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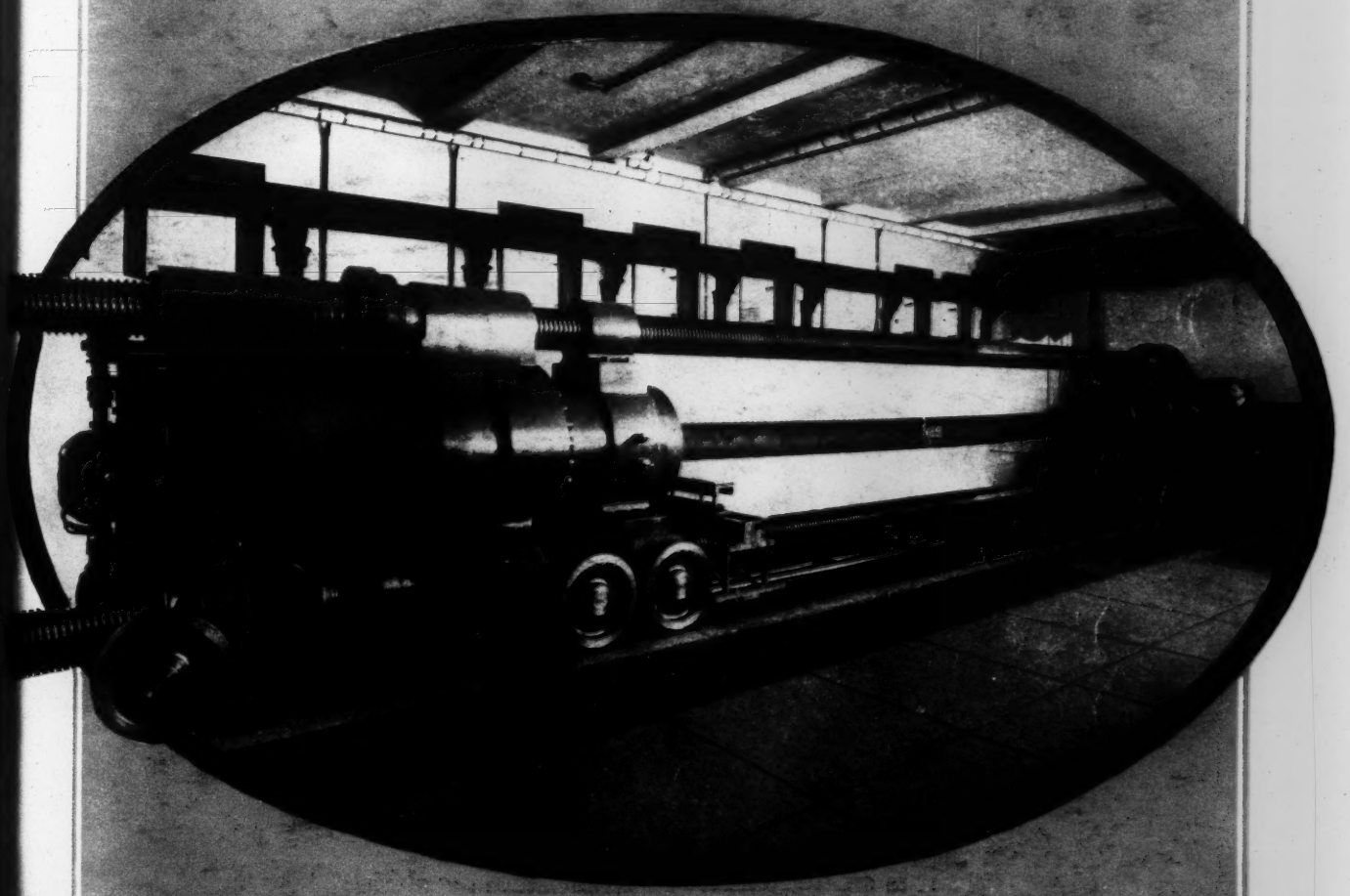
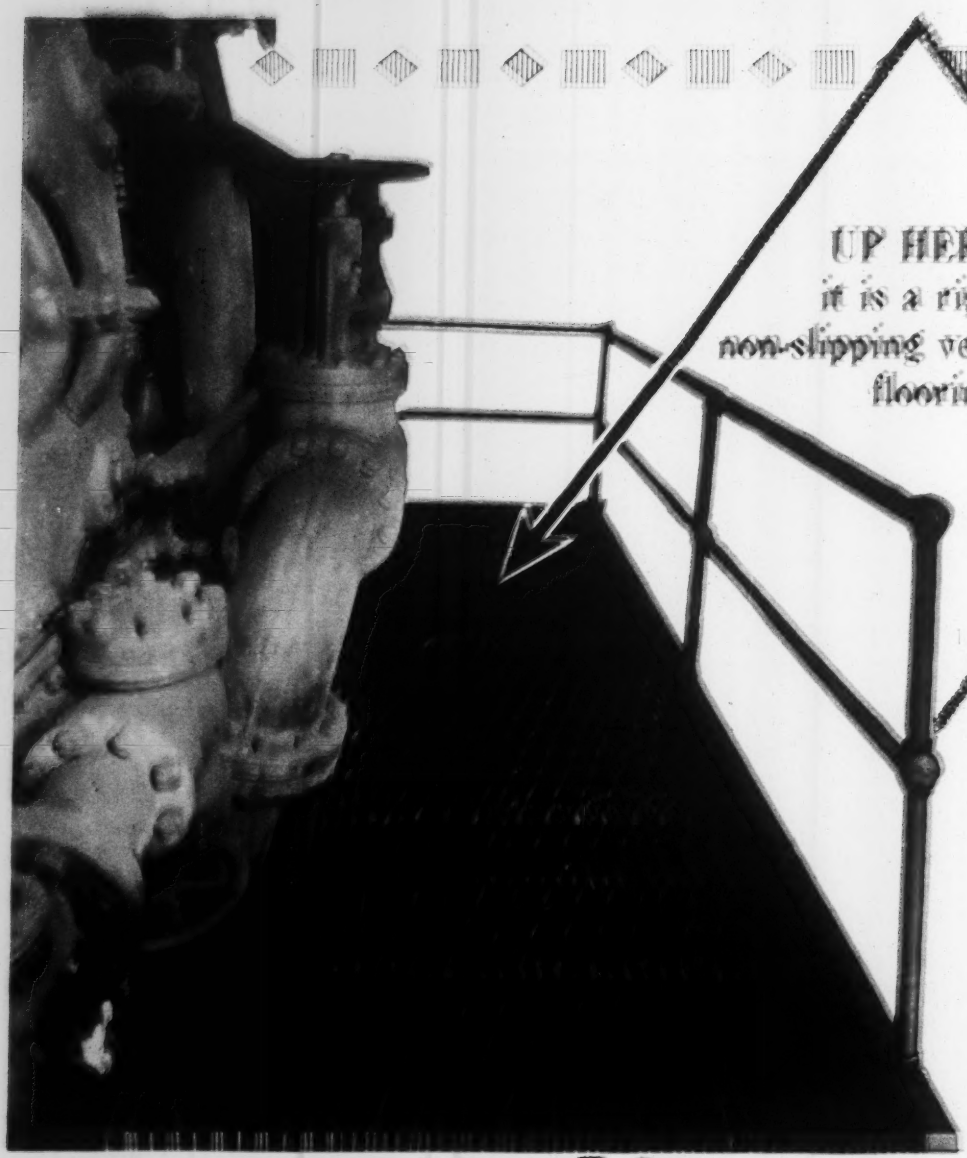
April 26, 1917



An insistent demand for large-size tests of structural members sprang from the disastrous Quebec bridge collapse in 1907. The United States Government met this demand by constructing two huge testing machines. What work have they done?

An official answer is given in this issue. The great series of column tests made on the precision machine in the Washington laboratory of the Bureau of Standards constitutes a leading element of the answer.

Cover Released by Courtesy of Asbestos Protected Metal Co., First National Bank Bldg., Pittsburgh, Pa.



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As a matter of fact it takes a booklet to point out the full list of advantages of this grating-flooring.

Booklet AIA we call it—write for a copy **today**.

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Use it for stair and ladder treads.

Irving Iron Works Co.
Long Island City, New York

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A CONSOLIDATION OF ENGINEERING NEWS AND ENGINEERING RECORD
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Volume 78 NEW YORK, THURSDAY, APRIL 26, 1917 Number 4

Railway Forces Construct Viaduct Over Five Tracks

Erection of 50-Foot Girders and Slabs on D., L. & W. R.R. Facilitated by Use of Old Trusses on Timber Bents

WITHOUT interrupting traffic on the main line tracks, construction forces of the Delaware, Lackawanna & Western R.R. built an eight-span concrete viaduct at the Milwaukee Road bridge, about 2 miles west of Scranton, Penn., on the new Clarks Summit-Hallstead cutoff. The viaduct crosses five tracks in widely spread locations, as indicated by the accompanying photographs, there being six 50-ft. and two 45-ft. spans.

Special Construction Methods

The erection of the 50-ft. girders and slabs was facilitated by the use of old 50-ft. trusses on timber bents, which allowed traffic to continue on the main tracks without interruption. The floor steel was placed parallel to the skew in order to simplify the placing and avoid cutting at the skew expansion joints. This steel was placed in the bottom of the slab and designed merely to provide for possible single concentrations, the slab really acting in compression as the T-flange of the main girders, which were designed as T-beams.

The double columns were cast in one operation, the division between them formed by using a wedge-shaped partition in the full-width box form. This partition was given a slight start after the concrete had attained initial set, and no difficulty was encountered in moving it after the concrete had fully hardened. Owing to the small capacity of the concreting plant, the various spans were cast one-half of the width at a time, the construction joint being placed at the center of the roadway. Slabs and girders above the bents were cast monolithically complete between the expansion joints.

Provision for the effects of temperature without the use of sliding expansion joints is made in the overhead crossing. The central three spans, each 50 ft. long, expand each way by bending the supporting columns, while the outer ends of the bridge expand from the fixed end abutments also by bending similar columns on the inter-

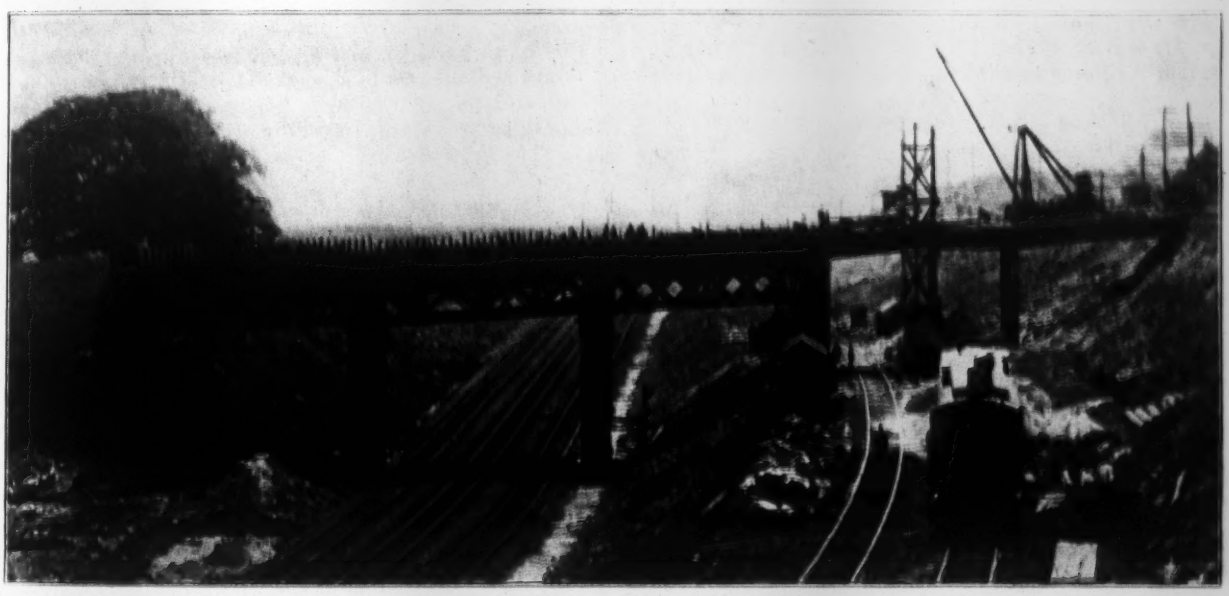
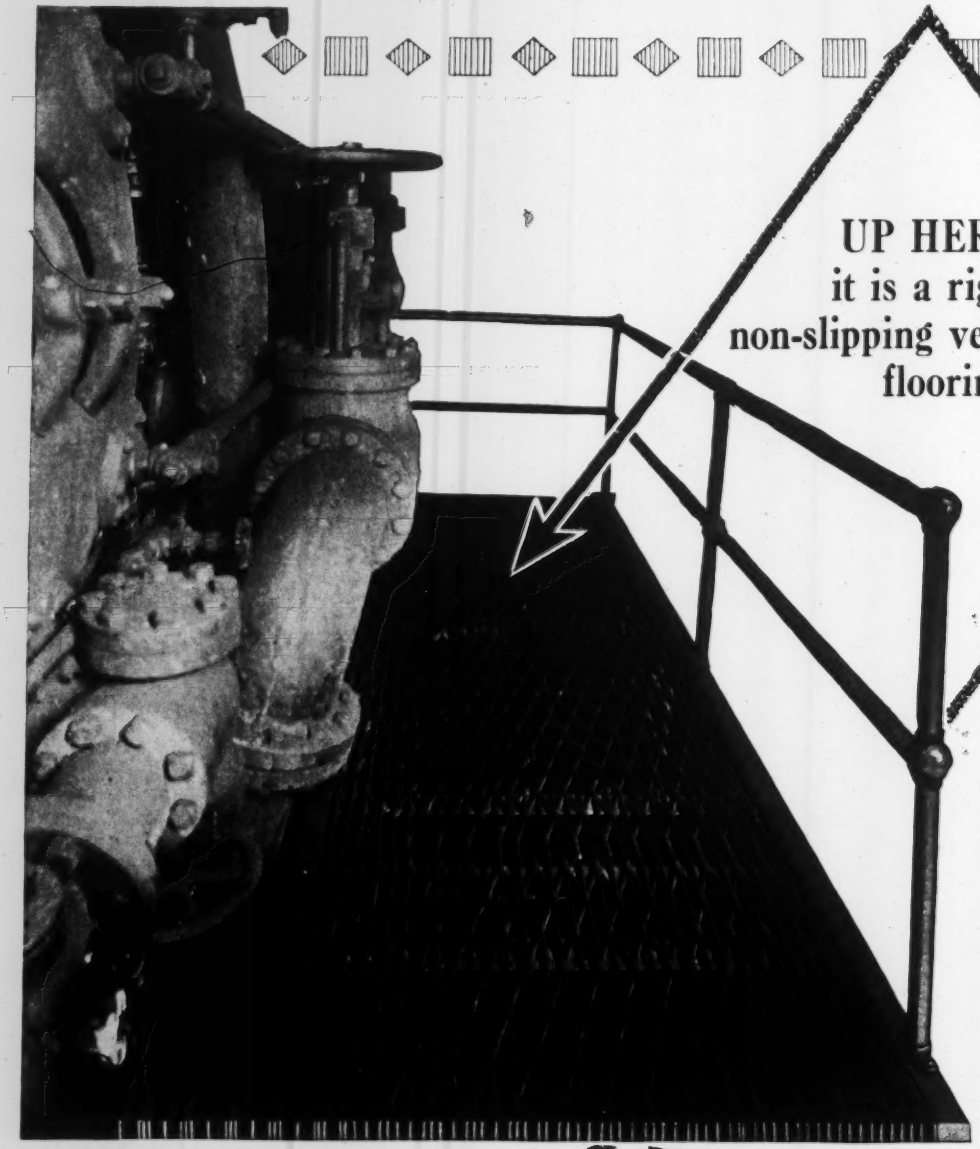


FIG. 1. OLD STEEL TRUSSES USED AS FALSEWORK FOR CONCRETE FORMS OF 50-FT. SPAN

mediate piers. These piers support double columns with about 1½ in. clearance between them. Another special feature resulting from the desire to eliminate sliding joints is the use of columns under each of the five rows of longitudinal girders. There are no cross-girders at any point in the structure.

Expansion Bents 150 Feet Apart

The viaduct consists of three 50-ft. spans at the north end, then three additional 50-ft. spans between the expansion bents with double columns, and two 45-ft. spans on the south end. The central span of the inside group crosses three tracks, the two main tracks and the east-



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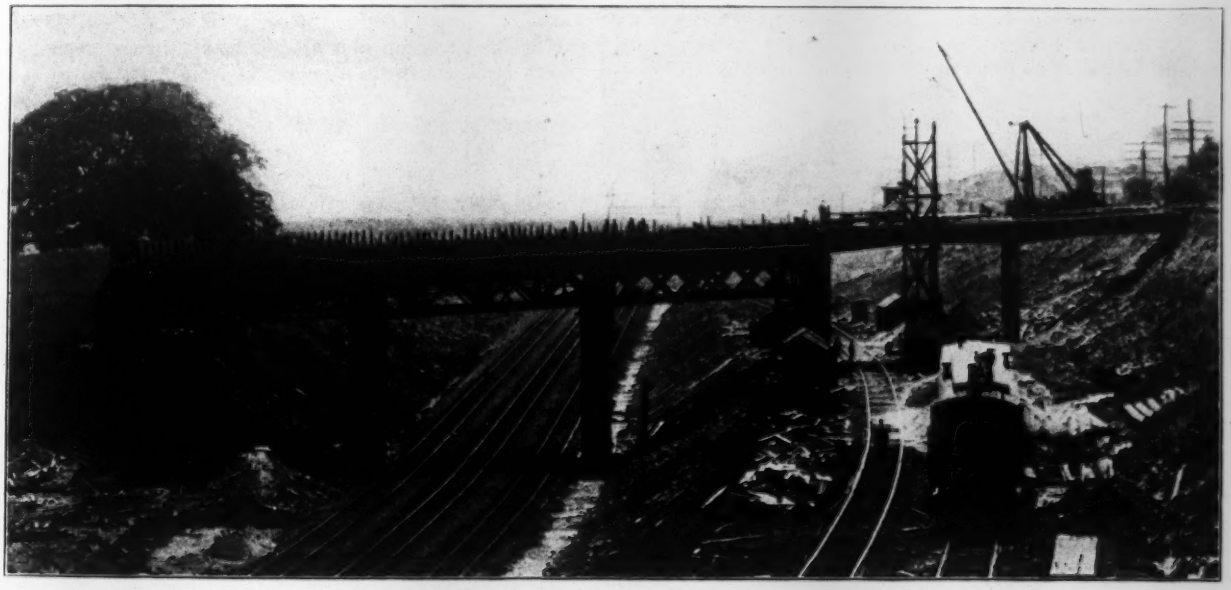

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FIG. 2. DOUBLE COLUMNS AT EXPANSION POINTS 150 FT. APART—COLUMNS SUPPORT EACH LINE OF GIRDERS

bound slow track of the new cutoff. The westbound slow track passes under the central one of the three north spans, while the two shorter spans on the south end are over the old abandoned main line.

As seen in Fig. 1, the typical bents are nearly 50 ft. high, the lower sections up to the intermediate struts being kept constant and the upper sections varied in height according to the grade. The bridge is on a 25° skew, and the cross-sections of the columns are therefore parallelograms, as shown on the drawing. The pier footings were carried to hardpan, and all piers next to the permanent tracks are solid up to a height at least 6 ft. above top of rail. Column forms and dimensions were made alike, so far as possible, in order to facilitate construction.

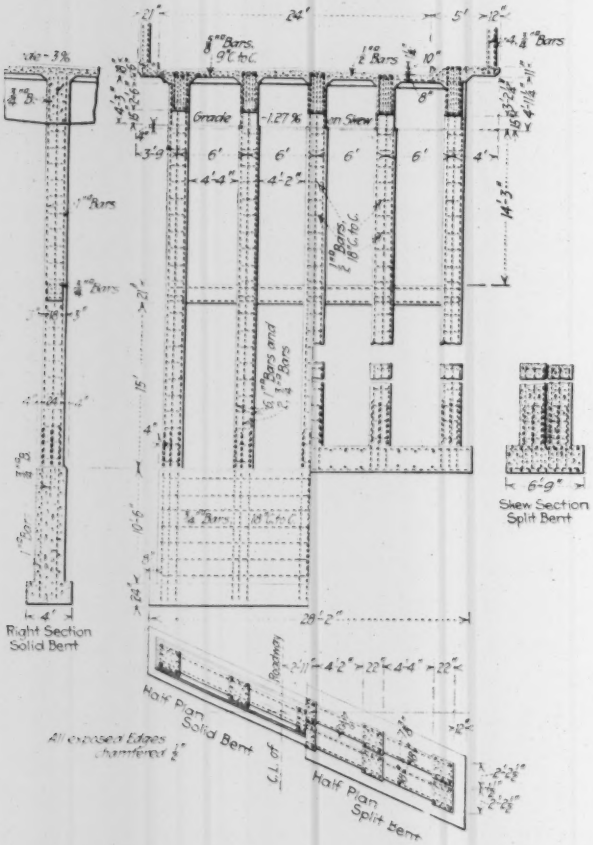


FIG. 3. DETAILS OF BENTS AND PLANS AT EXPANSION POINTS

Roadway Support

Five lines of longitudinal girders support the 24-ft. clear roadway and a 5-ft. sidewalk on one side, making an unsymmetrical right section, as shown in the drawing. These girders are curved on the under side to a radius of 172 ft., the 50-ft. girders having a rise of 15 in. and the 45-ft. girders of 12 in. at the center. This curved outline not only served to improve the architectural lines, but gave the necessary shear area at the columns and helped to increase the longitudinal rigidity.

Each girder is supported by a column at the intermediate bents, with two columns at the expansion bents, as already noted. The tops of these columns are connected by a rectangular strut on the skew between the main girders to give lateral rigidity, but are not reinforced for beam action. One intermediate strut connects the columns of each bent, the height of the columns being just about at the allowable limit for ratio of length to breadth, as designed, with sections 22 x 24 inches.

Live-loading was specified at 100 lb. per sq.ft., or a 12-ton roller on the roadway, both with 25% impact, and 80 lb. per sq.ft. on the sidewalk, without impact. Continuous beam action was considered in the design of the main girders, using $w\frac{1}{10}WL^2$ for the center bending moment, the uniform load governing.

This bridge was designed in the office of the chief engineer of the Delaware Lackawanna & Western R.R., G. J. Ray, under the direct supervision of A. B. Cohen, concrete engineer. It was constructed complete by railroad forces under the supervision of L. L. Tallyn, division engineer.

Unit-Construction Canopies Are Built on Curve

Erection at Danville Station Was Not Difficult, However— Material Saving in Column-Form Cost Effected

By G. E. QUICK
Superintendent of Construction, M. J. Hoffman Construction Company, Terre Haute, Ind.

BOTH unit construction and cast-in-place concrete were used in the canopies of the station of the Chicago & Eastern Illinois R.R. at Danville, Ill. The unit construction was complicated by the fact that the canopies were on a curve, so that each roof slab had to be slightly trapezoidal. Care had to be taken in the testing of the slabs, but neither the curve nor the grade of the platform caused any great difficulty of erection. As compared with the cost of the work that was poured in place, the greatest saving in the unit construction was in its erection and on the column forms. There was little if any saving in the cost of the slab forms.

The total length of the canopies is approximately 1000 ft. Of this, 450 ft. is unit construction, while the remainder, consisting of the double sheds in front of the main building, was too wide to be handled economically in this manner and was therefore erected in place.

The single sheds that make up the unit-construction work are composed of slabs 16 ft. long, 11 ft. wide and 4½ in. thick. Each slab was built in two units 5½ ft. wide to facilitate handling. As the roof is V-shaped, draining to the center, the inner edges of the slabs were beveled to fit, while the outer edges were cast with a curved finish. The slabs rest on T-shaped columns spaced 16 ft. on centers and are anchored by four 1-in. dowels at each end. A 3-in. stirrup at each end assisted erection.

Pouring Yard

A yard for pouring the slabs and columns was located along a siding about two blocks from the station. Owing to the facts that the derrick car used in erecting the slabs had only a 35-ft. boom and that the available space was limited to a short distance along one side of the siding, it was necessary to pour the slabs in two sections, one on top of the other. This required careful blocking under the lower slab to prevent uneven settlement.

Wooden forms were used, and to obtain a smooth surface they were carefully finished and covered with a heavy grade of Neponset paper and brushed with paraffin oil just before the pouring of the concrete.

The reinforcing for the slabs consists of triangular mesh under ½-in. rods. A ¾-in. layer of concrete was first placed on the forms, and the mesh and steel rods were then placed over this layer, the reinforcing thus being held in place without the use of chairs.

Since the canopies were built on a curve, the outer edge of the slab was longer than the inner one, making the ends out of square with the sides. By the use of a diagonal pole and careful checking of the side measurements with a tape line, this difficulty was overcome.

Casting the Columns

The columns are T-shaped, 12 ft. 8 in. high, with a 9 x 18-in. base. The total width across the T is 9 ft. 8 in. They rest on 9 x 18-in. piers, and four ½-in. rods extend 15 in. from the bottom of the column and form dowels, which were grouted in the slots in the piers. The piers were poured in place.

A carefully leveled platform was prepared for the pouring of the columns. The forms were placed so that the T's interlocked in order to save space. Eight sets of forms were required to pour the 32 columns. A single templet was used in setting each column form, so that the bearing edges for the slabs would be the same on all columns. The curved part of the columns was formed by nailing sheet iron on wood frames cut to the proper shape.

The greatest difficulty in casting the columns was in forming the bearing edge. Eight 1-in. dowels were set in the edge for engaging the slabs, and it was necessary to make this section in two parts so that it could be removed from the dowels without breaking the head of the columns.

THE FACT THAT CANOPIES FOLLOWED CURVE DID NOT GREATLY HAMPER UNIT CONSTRUCTION

A derrick car erected the columns, loading them first on a flat-car and then erecting and bracing them to place at the site. The slabs were handled in the same manner. In spite of the fact that the work was all located on a curve and that in addition each pier had a different elevation, the engineer laid the work out with such accuracy that no difficulty was encountered in the actual erection of either the slabs or the columns. When the men had become familiar with the procedure, the slabs and columns were loaded, hauled a quarter of a mile and erected at an average rate of speed of 15 min. for each slab and column.

The work was carried out under the supervision of J. W. Hunter, division engineer of the Chicago & Eastern Illinois R.R. Henry Raeder, of Chicago, was the architect. The M. J. Hoffman Construction Co., of Terre Haute, Ind., had the general contract, the writer being superintendent of construction.

Traveling Chutes Deliver Concrete from Central Mixing Plants to Winnipeg Aqueduct Forms

Part II—Experience Indicates Best Methods of Handling Forms —Backfill Is Placed by Dragline Bucket Dumping at a Height

By WILLIAM SMAILL

Superintendent, Winnipeg Aqueduct Construction Company, Limited, Winnipeg, Man.

In Part I of this article, published last week, Mr. Smaill dealt largely with the subjects of excavation and drainage. In Part II, below, he describes in detail the methods and plant employed in mixing and delivering concrete and in placing the earth backfill over the completed aqueduct.

THE nature of the ground traversed by the Winnipeg Aqueduct prevented the use of heavy moving plant for mixing concrete. The scheme finally decided upon was to have a central mixing plant at each opening and transport the concrete to the forms. The Greater Winnipeg Water District sells to the contractors aggregate, delivered alongside the railway track on the work, so at each opening a platform has been provided sufficient to carry a three days' supply.

Mixers Specially Made

At each of the camps a concreting plant consists of a ¾-yd. mixer specially made for the Winnipeg Aqueduct Construction Co. by the London Concrete Machinery Co. The mixer has an extra-large boiler, extension skids for loader, and loading skip made wide enough at the back to receive material from gravel cars without spilling over the sides. To facilitate moving, which occurs about every two months, the mixers are provided with special car wheels, standard gage, so that they can be shifted to and moved along the railway track. There are nine all-steel hopper side-dump cars of 30-cu.ft. capacity, made specially strong, fitted with springs on axles and spring chain heads to provide for smooth running and to prevent segregation of aggregate in the concrete during transportation. Six of these cars are used in transporting concrete, two behind the mixer handling gravel and one kept for spare. The plant includes also one Plymouth 3-ton gas dinkey for hauling concrete and one gasoline hydro-pneumatic outfit for water-supply—a 2-in. pump and an 800-gal. tank.

Gravel platforms are about 500 ft. long and are made by laying 4 x 6-in. stringers 16 ft. long on 2-ft. centers, at right angles to the track. The platforms are leveled up and on them 2½ x 12-in. by 20-ft. fir planks are laid loose with broken points for a width of 10 to 12 ft., varying with the height of the railway track above the platform. Two planks are set on edge to prevent gravel from spilling over the edge of the platform. The whole is securely braced to prevent sliding when aggregate is dumped from 20-yd. air-dump cars. The outer ends of the 4 x 6-in. stringers that are not boarded over are used to spike 20-lb. rails to, for carrying small hopper cars that transport gravel to the mixer. A cement house with a capacity of three cars of cement is placed behind the mixer at the center of the platform; this house is built in sections.

Two cars are used to transport aggregate from the platform to the mixer; they work from opposite ends of the platform, one car being at the mixer while the other is being filled by hand.

Mats Carry Mixers in Soft Ground

The company purchased from the district all the poles obtained during the clearing of the right-of-way. On soft ground a mat is made with some of these poles; and on this mat, cribbing or bents are set up to support the mixer at a height sufficient for the dumping of concrete into steel hopper cars that are run in on a small trestle, 3 to 6 ft. high, in front of the mixer. This trestle is a siding from the track on the dirt dump alongside the trench over which the concrete is transported; it was built in this manner at first on account of the unknown capabilities of the light gas dinkey, but this machine has proved so efficient that in later set-ups the mixer was

TYPICAL MIXER SET-UP SHOWS DISTRICT'S RAILWAY, GRAVEL PLATFORM, CEMENT SHED, LOADING CARS, CONCRETE TRAIN, NARROW GAGE TRACKS ON SPOIL BANK AND SECTION OF COMPLETED ARCH

simply placed high enough off the ground to dump into the cars, the dinkey being able to haul three 30-ft. cars of concrete up a 4% grade easily.

Three concrete cars are worked in a train, while the concreting dinkey is kept on the move all the time. By keeping the track in shape and using cars having spring axles and draw heads no trouble has been experienced with segregation of the aggregate. Hauls of ¾ mile from the mixer are the longest attempted, but a distance of ½ mile each way from the mixer seems to be the economical limit.

Concrete is dumped from the cars into steel chutes with tray-shaped hoppers at the receiving end; from the chutes the concrete runs into Blaw steel forms, which are used on all three contracts.

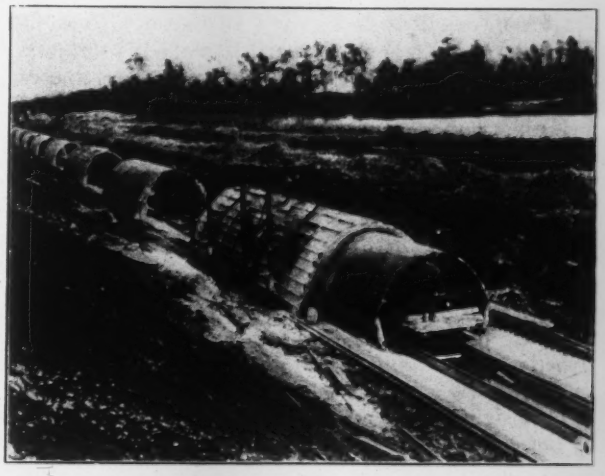
When starting concrete the invert profiles are first set with the copper expansion strip properly placed therein. A slight departure was made from the usual method of using a timber or plank to form the outside edge of the invert by substituting a 5-in. channel bolted to the ends of the invert profiles at correct distance that made a complete steel form that could be readily squared up and set to line or grade. The invert was poured in 15-ft. sections. The forms are set up for alternate inverts, the intermediate section being filled after these are sufficiently set so that the screeding iron will not scratch the surface.

Joint Between Invert and Arch

All concrete is mixed to a mushy consistency, and the inverts, after being poured, are screeded with 3½ x 2½-in. angle-iron provided with handles and operated by two men. After screeding they are troweled and worked to a smooth hard finish. On the shoulders of the invert 1¾ x 14-in. dressed pine strips are inserted into the concrete longitudinally, to a depth half that of the 1¾-in. dimension, the other half later entering the concrete of the arch section to make a water-tight joint. This portion of the invert is screeded on our work to an even surface, and when sufficiently hardened the surface is gone over with wire brushes and cane brooms until a clean surface of sand and gravel is left. Experience has shown that a joint so prepared and properly cleaned off before concreting bonds well to the arch and on testing shows practically no sign of leakage.

After a stretch of invert has been poured and become sufficiently hardened, the inside forms are first set up. They generally require a considerable amount of working into shape, to get lines and joints correct. The plates generally get sprung more or less in transporting, unloading, etc. When they are made true to shape, the travelers that handle the inside forms and that operate on light track placed on the invert are run under them; and 15-ft. arch sections are transported to the different points on the invert for the first set-up. The forms are then carefully oiled with form oil; bulkhead forms with copper expansion strips inserted are set up and bolted to the ends. The outside form sections are then set and attached to the inside forms, the proper spacing between inside and outside forms being maintained by means of taper tie-bolts and spacing blocks. The latter are removed as the concrete reaches them, and the former are driven out after the concrete has set, the holes left being plugged with short pine plugs about an inch long. The rest of the hole is filled with mortar.

When concreting had proceeded for a while, it was found expedient to make several changes from the methods that were in use with these forms. In the first place, it was found that the usual procedure of collapsing the inside form to move it through another form took considerable time. Then too, when the upper portion was collapsed, the drawing in of the sides worked the joints so much that a certain amount of relining and bolting up at the vertical points of the 5-ft. sections had to be done after each set-up. The longitudinal joint on top would at times be found hard to get together. This difficulty was overcome by arranging the set-up so that no inside forms would have to be passed through other forms. Pioneer forms were set up so that each set of inside forms would have three moves backward, when they would all be moved ahead far enough on the invert



ONLY THE BOTTOM WING PLATES ARE COLLAPSED WHEN INSIDE FORM IS MOVED OUT

to continue this procedure. This meant having twice the number of inverts laid ahead and double the amount of inside track, but the change paid for itself many times over, as all that had to be done was to draw in the bottom wing-plates slightly with the turnbuckle on the traveler and then lower the whole form bodily with the traveler jacks just enough to pass out of the arch. In this manner the inside arch form was practically maintained in shape, moved and set up without the trouble of fixing joints every move.

The outside forms were designed so that they could be taken apart in sections, none of which weighed over 150 lb., so that they could be carried by the laborers. This was never done, but they were at first handled in 5-ft. sections, lifted out of the trench by a small hand-operated traveling derrick (working on the same track that the concrete cars run on) and loaded on a flat-car on the same track. When this car was loaded, the gas dinkey would move car and derrick to where the outside forms were required, and they were set in place with the assistance of the derrick.

Form-Handling Traveler Designed

While better than the original scheme of placing sections by hand, this method proved too slow and at times interfered with the use of track for concrete operations. As the ground generally was too soft to have any heavy

handling plant, it was decided that a traveler working in the ditch was the best solution for handling the outside forms. The scheme was to operate the traveler on 20-lb. rails 20 ft. long, spiked to 4 x 10-in. by 20-ft. planks laid along the side of the ditch. The Dominion Bridge Co. was asked to prepare a design, which was accepted. The new traveler picks up the outside forms bodily and moves them over the arches and other forms to wherever required. For the two camps started in 1916, where the forms are heavier, an improved and better design has been completed.

In the first traveler the form is raised by long levers with ratchet and pawl on pipes set horizontally along the sides; on these pipes are short chains or cables with adjusting turnbuckles attached to equidistant points near the bottom of the steel forms. The long levers working the ratchet and pawls wind the cable on the pipe, pulling the form from the concrete and raising it high enough to pass over the other arches and forms.

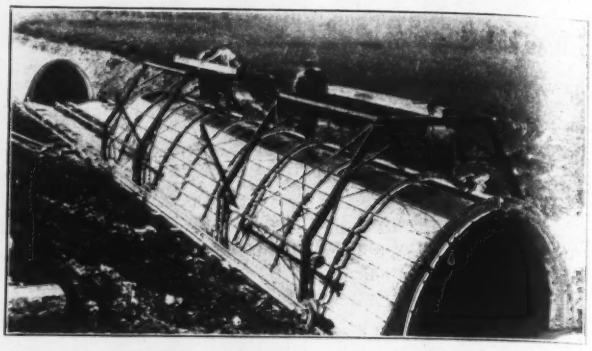
The newer traveler has a pipe running along the center of the top of the frame; cables attached to this with adjusting turnbuckles at the bottom are connected with both the bottom and the top of the form. These cables are wound up on the pipe by a gear driven by a pinion rotated by two hand-cranks, the men working from small platforms conveniently set on the traveler. These travelers, with load, are towed from place to place by running a light cable to the gas dinkey. In this manner the moves are quickly and easily made. The crank and track are picked out of the ditch by means of the small traveling derrick and placed ahead in the ditch at convenient times.

The original outside forms were brought up on the side of the arch only so high that a thin steel spade with a ½-in. pipe handle could be worked inside the forms and reach to the bottom of the arch. This necessitated the making of a drier mix that would hold up on the slight slope above the tops of the outside forms. This portion had to be carefully worked and screeded in place. The inside forms would of course not stand up under any severe tamping. It was found advisable to procure extra plates that could be fitted in and put in place after the concrete was carried up to the height of the original outside forms. These plates, which could be speedily set in place, left an opening only 16 in. wide on top of the forms through which the remainder of the concrete was placed, requiring no change in the consistency of the mix and doing away with the screeding of large surfaces on the top of the arch. Also, what the writer thinks is of more importance, the arch concrete was placed continuously and was of uniform consistency.

The concrete was run into the arches and inverts by means of steel or wooden chutes, as described in the "Hints for the Contractor" Section of this issue.

Fill Compacted with Water

Where sometimes the muskeg is too deep or the ground too compressible, trench excavation has to be carried below the grade line of the invert to procure a firm unyielding foundation. The bottom is brought up to grade line by means of a foundation fill of pit-run gravel, and the most effective way of compacting this material has been found to be by means of water in the following manner: The section of trench to be filled is cut off from the rest of the work and allowed to fill with water to the required grade line. The pit-run gravel is shoveled into the water and brought up to the grade line, where it is roughly shaped for the invert. The water is then pumped off; when drained, the fill is a solid compact mass that requires the use of a pick to move any of it. From some measurements taken it is just as solid shortly after the water is drained off as it is any time later.



TYPE OF TRAVELER FIRST USED FOR SETTING OUTSIDE FORMS

Dragline Places Backfill

The backfilling of the completed aqueduct is accomplished by means of the Bucyrus dragline that excavated the trench. The contract calls for the first 4 ft. in the trench to be placed in layers and compacted by hand tamping, where the trench is in fairly solid material and the spoil can be placed on the sides of the trench. This can readily be accomplished, as material can simply be shoveled into place and tamped. But on the long sections of deep cuts and ditches with compressible sides the heavy solid material that would be needed for this tamped backfill had to be placed as far away from the sides as the boom would reach, to prevent slides.

Early this season the district's engineers wished to make some experiments as to settlement, if any, caused by an excess of backfill at points where the foundation was in clayey material. As the machines were busy elsewhere and the engineers were desirous of completing these tests as soon as possible, this backfill had to be all placed by hand and was done under the careful supervision of the district's inspectors. When the backfilling with draglines was started, some of it was placed in the usual manner, placing and tamping the first 4 ft. by hand. Later, we were allowed to make the experiment of backfilling entirely by machine, getting the tamping effect by the height the material is spilled from the bucket. It was thought there might be some shock to the pipe, but this is not so; the material spills out of the bucket in a continuous stream into the space between the pipe and the sides of the ditch, compacting the mass evenly and forcing it against the sides of the ditch and pipe, even with the 3½-cu.yd. bucket of the class 24 machine. No one inside the pipe can tell where or whether the machine is working or not.

After the backfill had been trimmed off and allowed to settle for a month or so, it was noticed that the test sections that were all hand backfilled had settled badly and were full of cracks. The portions partly hand-tamped and machine-filled were a good deal better, but will all

have to have cracks filled up. The sections made altogether by the dragline machine show practically no signs of settlement cracks, and what cracks there are could certainly have been avoided by dumping material from buckets at a slightly greater height. These sections proved conclusively the great superiority of an intelligently handled machine backfill over that placed by common labor. Advantage was taken of the insulating qualities of the muskeg or peat for the frostproofing of the aqueduct; wherever possible, a layer of this material was placed immediately over the concrete.

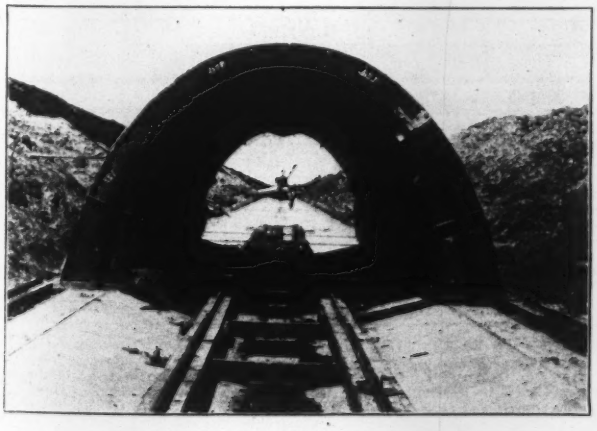
In the big cut the solid material is filled almost to the top of the arch; then a couple of feet or more of muskeg is placed over the arch, and this layer is covered with sandy clay to a depth of 5 ft. over the crown. The final trimming of the backfill is generally made by stationmen using a wood templet for shaping, the top width of backfill being not less than the inside width of the aqueduct and the side slopes $1\frac{3}{4}$ to 1. After standing over winter, the dump is finally shaped and seeded with a mixture consisting of brome grass, rye grass and white clover.

River Crossings

The river crossings are taken care of by means of inverted siphons. There are five of these crossings on the three contracts. Owing to the flashy nature of these streams in times of summer rains, it was decided to put the siphons in during the winter months while the rivers were low; the four largest are now completed.

The Falcon River crossing was put in this year under very severe weather conditions, the thermometer showing almost steadily from 10° to 45° below zero. During the months of December and January there was required close supervision of the warming of concrete materials, also protection from freezing after pouring. Materials were heated with steam jets, and concrete was protected by steam or coke fires in salamanders under canvas covers.

In the two seasons just completed, notwithstanding the labor shortage and its quality (most of the camps this season could only be about half manned), camps were built, plant installed and, to date, we have excavated $24\frac{1}{2}$ miles of trench, 15 miles of drainage ditches, backfilled 20 miles of aqueduct, and put in four river crossings.



ARCH FORM READY FOR CONCRETING

Note tie rods to prevent spreading; anchors to invert are provided to keep form from rising

Some tests for water-tightness are under way and have been going on for some time. Taking figures from the first two months of testing, the total leakage per mile would average 500 to 600 gal. per day. The average leakage per square foot of surface is 0.006 gal. per day; and that of the jointing planes per lineal foot, 0.04 gallon.

The method of making the test is to construct brick bulkheads cutting off a 300-ft. section, making these bulkheads as high as the maximum flow line. Bulkheads are waterproofed with cement mortar and are fitted with gage glasses for reading water levels. The aqueduct is well cleaned before the bulkheads are built, and then water is pumped in to the required level; the first reading is taken when the surface agitation of water has stopped.

Personnel

The officers in charge of the work for the Greater Winnipeg Water District are James H. Fuertes, consulting engineer; William G. Chace, chief engineer; and M. V. Sauer, assistant chief engineer. Mayor F. H. Davidson is chairman of the Administration Board. The commissioners are James J. Ashdown, and ex-mayor R. D. Waugh, chairman.

The officers of the Winnipeg Aqueduct Construction Co. are A. C. McKenzie, president; A. H. Aldinger, vice-president; F. E. Halls, secretary-treasurer; and J. B. McLean, manager.

The Engineer as a Business Man

In a recent address before the Chicago Association of Commerce, on "The Business and the Function of the Consulting Engineer," Robert Isham Randolph referred to the frequent subordination of the competent engineer to the business man, as follows: "The engineer must consider the advancement of the art—new inventions, new applications, improved methods. We throw into the scrap heap, today, machines and processes which were devised yesterday. Not because they are worn out, not because they are not effective, but because new machines and new processes are so much more effective and economical that we cannot afford to retain the old.

"Some may say: 'This is not the function of the engineer. These are matters to be decided by the mature judgment of the business man.' Alas, the engineer is not often allowed to decide these most important questions. He may advise, argue, plead, but the decision usually lies with a council of 'business men.'

"Webster defines business as 'that which engages the time, attention or labor of anyone, as his principal concern or interest, constant employment, regular occupation.' I ask you, Which is the business man in such a case, the engineer, whose time and attention and labor have been engaged on this matter as his principal concern and interest, the engineer whose constant employment and regular occupation has been thinking and planning and studying and solving the problems so vitally affecting the public welfare, or the council member who gives one night a week to a discussion of the problem with others of his kind?

"The structure which trained minds, specialized endeavor and almost inspired vision have created may be wrecked by the lottery of a miscellaneous assortment of yeas and nays that are in the mass utterly incompetent, whatever the attributes of individuals who voice them."

Weekly Report Forms Simplify Highway Engineers' Work

Progress on Illinois State Roads Is Submitted on Standardized Printed Sheets—Accurate Records of Material Kept

By M. W. WATSON
Assistant Road Engineer, Illinois State Highway Department

THE EXPENDITURE of practically $2,000,000 per annum for state-aid road improvement in Illinois, distributed among 102 counties, necessarily involves a number of scattered sections of work that are in the process of construction at the same period, each requiring an inspector or resident engineer. In order to supervise the work of these men, the state is divided into seven districts, each in charge of a division engineer who is held responsible for all fieldwork, regardless of character. An adequate system of reports is therefore required, in order that the division engineer and his superiors may be able at all times to obtain complete information concerning each section of work.

To obtain the desired information, all resident engineers were required in the beginning to furnish daily reports on each assignment under their charge; but this system was soon found to produce an excessive amount of office work, for it was necessary to examine these reports and tabulate the progress of work throughout the state without the compensating advantage of keeping the main office in closer touch with the work. A report form was then adopted which covered a calendar week, and the resident engineer was required to furnish one copy to the division engineer, as well as one to the road engineer's office at Springfield. This report consisted of two sheets and has been in continuous use until recently, when it was found that the information was inadequate, owing to the advent of road types not previously encountered. A revision was necessary in order to furnish a complete report. The first sheet of this revised report is given the title of "Weekly Report of Resident Engineer, Labor," and is reproduced in the illustration herewith.

(P2977-3M) Contract

STATE OF ILLINOIS
STATE HIGHWAY DEPARTMENT
SPRINGFIELD, ILLINOIS

No.

WEEKLY REPORT OF RESIDENT ENGINEER

LABOR

Section , Route , County , Type of Road

Road Begins at Sta. Ends at Sta. Week Ending 191

Sta.	1 mi.
Excavation Compl.	
Subgrade Compl.	
Aggregate Placed	
Base Laid	
Pavement Laid	
Pavement Completed	
Completed Road	

LABOR REPORT IN MONEY

Items of Work	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Total
Superintendence								
Excavation								
Hauling and placing tile drains								
Bridge and culvert work								
TOTAL EXPENDITURE								

EXTRA WORK NOT IN CONTRACT

Authorized	Items	Actual Cost	Profit	Total

Resident Engineer. Address

Telephone No.

WEEKLY LABOR REPORT OF RESIDENT ENGINEER, ILLINOIS STATE HIGHWAY DEPARTMENT

Under the subject heading "Items of Work" the following subdivisions (omitted to reduce the chart to reasonable size) appear, each one occupying a separate line in the first column of the blank form: Superintendence; excavation; loading coarse aggregate; hauling coarse aggregate; loading fine aggregate; hauling fine aggregate; loading and hauling cement; loading and hauling bituminous materials; loading and unloading brick; hauling brick; incidental hauling; shaping and rolling subgrade; mixing and placing concrete; handling forms and joints; covering, seasoning and cleaning concrete; placing and preparing sand cushion; laying and rolling brick; grouting joints in brick; spreading stone; rolling and sprinkling; heating bituminous binder; applying bituminous binder; mixing and placing bituminous concrete; shaping and rolling earth shoulders, gutters and side roads; mixing and placing concrete gutters; hauling and placing macadam shoulders; hauling and placing tile drains; bridge and culvert work

(P2978—3M) 2

STATE OF ILLINOIS
STATE HIGHWAY DEPARTMENT
SPRINGFIELD, ILLINOIS

Contract No.

WEEKLY REPORT OF RESIDENT ENGINEER
MATERIALS

Section ....., Route ....., County ....., Type of Road .....

Week Ending 191

CEMENT RECEIVED					MATERIALS RECEIVED
Car Initial	Number	R. R. Weight	Sample No.	Reported	Tons of stone or gravel
					Tons of sand
					Tons of screenings
					Gallons of bitumen

BRICK RECEIVED					REMARKS: Use R. R. weights for above materials
Car Initial	Number	R. R. Weight	Sample No.	Reported	Note with car no's any rejections of above materials

CEMENT

Date	Pavement Sta.....to.....Sta.	Theoretical Amount Required	Cement Used	Surplus	Deficiency

TOTAL bbls. received this week

TOTAL bbls. received for entire job

..... Resident Engineer. Address .....

WEEKLY MATERIAL REPORT OF RESIDENT ENGINEER, ILLINOIS STATE HIGHWAY DEPARTMENT

Work in one county is distinct from that of any other, and all state-aid funds are required by law to be expended along designated state-aid routes. Each route has a separate number, and each contract is designated by a section letter. It is advisable therefore to provide adequate space, preferably at the top of each form, for the purpose of indicating this information. The notation concerning the beginning, ending and type of construction is for the convenience of the office force in checking over these reports.

Space for Graphic Chart

Immediately following this space is found a chart for indicating graphically the progress of important features of the work. All progress up to the beginning of the week for which the report is made is indicated by filling in the parallel lines in solid black, and the construction for the week for which the report is made is indicated by crosshatching the length covered. Thus the division engineer or the road engineer can determine from each weekly report the exact progress of the work and prepare a chart that will indicate to anyone who is interested in the work the progress of all state-aid road work to date.

Following the progress chart is found the labor report in money, each item of work being listed and a space provided to take care of it for every day in the week. The total expenditure for each day and for each item is shown. The resident engineer is required to make these totals, and by taking a summation of each set of totals he is furnished with a check on his computations.

All extra work not provided in the contract, for which the contractor is to receive actual cost plus 10%, is listed in the space provided at the bottom of the form.

The second sheet of the report, as shown, is intended for materials. Since the State Highway Commission furnishes all cement in connection with state-aid road contracts, particular attention is given in the report on materials to the amount of cement received, as well as to the amount used in the work. The cement received is indicated by car number and size; and space is provided to indicate for each day of the week the amount of pavement laid, the theoretical amount of cement required and the actual quantity used during that day, from which can be extended either the surplus or deficiency of cement used. When an excess of 2% is used for any one day, the contractor is required to pay for the

additional cement. When a deficiency of more than 2% is found, he may be required to remove that section of the pavement in which the deficiency occurs.

Particular attention is also given in this report to brick received, as it is provided in state-aid road contracts that, upon proper authorization by the contractor, the State Highway Commission will pay the brick company for all brick delivered on the job. This is also of value in checking the brick tests, which are reported from the laboratory. As practically all other materials used are furnished by the contractor, a total of the amount received is all that is indicated.

For convenience of the engineer and to insure a duplicate at any time should the reports be lost in transportation, each resident engineer is provided with a cost record book, which contains space for tabulating all the items indicated on the weekly reports, as well as space for a more detailed record of all items. When accurate cost data are required for any particular feature of the work, the only step necessary to obtain this information is to check the figures indicated on the weekly reports.

Since these reports have been in use, it has been found that they are adequate and have permitted an accurate cost record and progress report to be maintained.

Common Labor Hard To Hold on Job of Track Elevation, Rock Island Finds

Men Stay on Work an Average of Only 4.8 Days—Additional Cost of Constant Changes Mounts Up to a Considerable Sum

THE labor problem in relation to railroad as well as other construction work is becoming a more serious matter every year. It is estimated that in 1916 about $60,000,000 worth of construction work was authorized on the railways in the Chicago district. A large proportion of this, however, went over until 1917, owing in part to the labor conditions. On the Rock Island Lines considerable study of the problem has been made, with the aim of finding some means of securing greater efficiency and economy in labor. A specific investigation is being conducted on the extensive track-elevation work in Chicago, which work is being done on the company-force system. There is a special organization for this work alone, under a general staff (see *Engineering Record* of Aug. 1, 1914, p 122, and *Engineering News* of Apr. 8, 1915, p. 673), so that the work constitutes an independent job with its own system of accounting.

Common Labor Classified

This investigation deals exclusively with common labor, which, for the purpose of the inquiry, has been divided into three classes as follows:

1. *Native Labor*—This comprises men who reside in the vicinity of the work and most of whom maintain homes within easy access of it. As a rule no additional expense beyond their wages is incurred by the railway on account of these men.

2. *Foreign Labor*—This comprises men who come to the work in groups, usually through an agent or one of their number who acts as a leader. These men generally board themselves. The railway furnishes more or less transportation and provides bunk-cars for housing.

3. *Tramp Labor*—This consists of men who are nearly all employed through labor agents and for whom transportation, boarding and feeding facilities are provided by the railway. Laborers in this group differ from those in group 2 principally from the fact that they are employed singly and that their service usually is of short duration.

Last year a large part of the labor consisted of tramps who had acquired restless habits, as shown by the tendency to quit work after a few days' service and move on to other jobs, very often irrespective of the wages paid. This tendency makes it difficult to organize and maintain gangs for efficient work, since they are being continually recruited by new men. The foreign laborers also are always ready to move to other work with practically no notice. All of this is demoralizing to the force and detrimental to efficiency, speed and economy of work.

Transportation and Housing

In addition to this, the transportation and housing of numbers of men who remain but a short time on the work represent a material increase in the labor cost. The cost that the railway incurs for the two latter groups of labor, in addition to the regular wages of the men, is shown in Table I. It represents from 3.4 to 3.6c. per man per hour (working time).

TABLE I. COST OF LABOR ON TRACK-ELEVATION WORK IN CENTS PER HOUR WORKED

	Foreign Labor	Tramp Labor
Transportation to and from work	1.69	0.93
Feeding (ice and transportation of provisions)		.89
Fuel for heating bunk-cars	.26	.26
Fuel for cooking	.14	
Camp equipment and repairs	.40	.30
Investment in camp facilities	.14	.08
Insurance (employers' liability)	.94	.94
Total extra cost	3.57	3.40
Average rate of pay	18.05	18.05
Total cost to railway	21.62	21.45

TABLE II. NATIONALITIES OF MEN WHO DID NOT STAY ON WORK, AND REASONS FOR LEAVING

Reasons for Leaving	Number of Men	Nationalities	Number of Men
Sick	250	American	338
Need money	214	Irish	573
Need clothes	117	German	224
Poor food	164	Swede	176
Poor water	23	Slav	170
Too hot*	112	Jew	2
Too cold †	30	French	4
Dissatisfied	118	Italian	9
Work too hard	97		
Laid off	38		
Discharged	11		
Various	372		
Total	1,546	Total	1,546

* July–August. † November–December.

On the Chicago track-elevation work, in order to obtain sufficient labor, it was necessary for the railway company to provide transportation and housing facilities and otherwise care for a large part of the common labor employed. The housing facilities consisted mainly of

CONCRETE POLES AT WENATCHEE WERE CAST IN PLACE USING WOODEN FORMS

bunk-cars, which were box or furniture cars dismantled and set on the ground, credit being taken for the trucks, which were removed. From July, 1913, to June, 1915, bunk-cars were furnished to foreign laborers, who provided their own food. Since that time, under agreement with a contractor who makes a business of boarding and feeding workmen, eight cars for kitchen and dining service have been added to the camp equipment. The railway company furnished free to the contractor the coal used in the kitchen cars, also the ice and transportation on provisions from point of shipment on the company's lines.

During the last six months of 1916 a weekly record was kept of the number of men hired and the number who quit the work. The summary for this period shows that 2874 men were hired and 1546 men quit, the average period of service per man being only 4.8 days. As it takes time for a man to understand his duties and get accustomed to the work, it is evident that the really serviceable time of the men averaged even less. The average number of men in the working forces was about 400. The record shows from 50 to 163 men hired per week and from 28 to 118 men leaving, while the days of service or employment per man ranged from 1½ to 8 days. Thus out of a total of 2874 men hired, 54% left the work in from 1½ to 8 days. The effect of this upon the progress and cost of the work can easily be seen.

Reasons for Quitting

Care was taken to inquire into the reason for each man's leaving. Table II shows a summary of reasons given and shows also the nationalities employed. It will be noticed that only 11 men out of 1564 were discharged. Drink is at the bottom of the reason given in many cases, although it does not appear directly in the tabulation. It covers many classed as "sick" and "needed money." In the latter case, as the men are boarded on the work, it is not often that a man really needs money so urgently as to necessitate his quitting work in order to draw his pay. In too many cases it was evident that these men left and drew money in order to go on a spree. It is stated that the men were well fed; and while 164 gave "poor food" as a reason for leaving, this is attributed to the fact that many of the men when hired were recovering from previous sprees and were in no condition to appreciate or assimilate good, plain food.

Of the tramp labor 37% of those who quit in a short time were Irish, 25% American, 22% Scandinavian and Slavic and 14% German.

The rates paid for common labor on construction work are higher than those paid on railway maintenance work, due largely to the fact that, in the former, employment is more or less temporary and the work is more arduous. In view of the higher pay and the fact that the work is carried on steadily for at least six months, while the men are apparently well cared for and well treated, it appears that careful study of the whole problem is desirable.

Concrete Electric-Light Poles Built in Place in City Park

City Engineer F. J. Sharkey, of Wenatchee, Wash., Explains Construction Details and Gives Costs

IN WENATCHEE, Wash., the necessity for building quickly and cheaply a small number of electric-light poles led to the adoption of a cast-in-place concrete pole of a design made by the City Engineer, F. J. Sharkey. The two views herewith show one of the poles under construction and a finished pole.

The trenching for the entire system was done first. The location of the pole bases was then carefully staked out; and stakes were driven in the bottom of the trench for the ends of conduit, so that they would coincide exactly with the inner walls of the junction boxes. The pole bases and junction boxes were then constructed and left rough over the area to be covered by the poles, the dowels and conduit elbows being placed at the same time. After the pole bases had thoroughly set, the forms for the pole were erected over the base, braced either to surrounding trees or stakes, and the pole cast from the top, a long slice bar being used to insure proper filling. A 1:1:1 mix was made for the pole, the coarse aggregate being a fine local gravel that was screened between ¼- and ½-in. screens.

Only Five Poles Built

As only five poles were to be built, the forms were constructed of wood in two sections, by a local cabinetmaker. These forms were not very satisfactory, requiring careful collaring and judicious treatment to prevent them from warping to such an extent as to preclude their further use after the first two poles were built. In the opinion of the City Engineer, for any considerable number of these poles pressed-steel forms would be more satisfactory. The cost of the poles complete was as follows:

Forms	$14 00
Labor, setting forms, mixing and placing concrete	46 25
2½ cu.yd. sand @ $1.25	3 10
2½ cu.yd. gravel @ $1.75	4 40
4½ bbl. cement @ $3.00	14 00
50 ft. of 1½ in. conduit	8 06
Five 1½-in. conduit ells	2 29
Ten 1½-in. bushings	95
5 meter-box frames and covers	10 00
Five 16-in. globes @ $4.30	21 50
5 series receptacles	5 00
Labor and material, making globes and socket holders	8 55
Total cost	$138 10
Cost per pole	27 62

What Our Large Testing Machines Have Accomplished

Bureau of Standards, To Meet Demands After 1907, Acquired Two Great Machines of Unusual Capacity and Precision

By T. J. MOSLEY and J. H. GRIFFITH
United States Bureau of Standards, Washington, D. C.

AUGUST 29, 1907, the date made memorable by the fall of the first Quebec Bridge, marks an epoch in testing, as it does in structural engineering. Large-size testing—testing of full-size pieces far beyond the capacity of prior testing machines—was developed in answer to the demand presented by the accident of that date. Through the construction of the Bureau of Standards' two large machines the scope of mechanical testing was extended remarkably.

What have the large machines accomplished? It is now 10 years since the inception of the movement for large-size testing. The two machines extend the load range of testing by four or five times—to the 10,000,000-lb. capacity of the Pittsburgh machine. And on the other hand, in the Emery machine at Washington they multiply the range of precision testing, making possible the highest type of testing up to capacities of 1200 tons, when before only the crude figures of press loading could be obtained. These are great advantages. They have been utilized well, to the profit of engineering and the constructive arts.

Demand Large-Size Tests After 1907

No one familiar with the engineering of the period preceding 1907 can contend that all minds were at ease as to the performance of large structural columns. There was a widespread feeling of discontent with formulas derived from laboratory specimens and applied to the larger and larger members necessitated in practice. Neither can one study the history of the gigantic Quebec cantilever without discerning the tremendous inertia of custom. "Why, if you condemn chord A9L, you condemn the whole bridge," protested A. H. Birks, the Resident Engineer, with his death-sentence on his own lips. Up to the hour of its collapse the Quebec Bridge was widely accepted as a model of design.

The catastrophe of Aug. 29, 1907, with the faulty behavior of certain compression members, brought into immediate exigency the questionings of 15 years. Immediately (Sept. 5, 1907) we read in the editorial columns of *Engineering News*: "No one has dreamed of doubting their strength; but now, with the testimony of that gigantic collapse, every engineer must long to know, by absolute trial, what such hugh columns can safely bear. Did one of them fail under a load only one-half of the elastic limit of the material in it?"

For the remainder of the year we find the editors and correspondents of the technical journals raising the same issue with increasing definiteness as the testimony brought forth by the Canadian Commission gave day by day more weight to the assumption of an initial failure in compression. With the testimony of Theodore Cooper, Oct. 14-19, 1907, this belief attained practical certainty, and the engineering profession candidly faced the fact that the time was at hand for a revision of part of the basic data of structural design.

Suggestions at once appeared for the stiffer fabrication of large compression members; but though wisdom after the event made these appear convincing, their value could not be proved by test. So soon as this fact was realized, it became evident that a machine capable of testing to destruction full-sized structural columns was a vital engineering need in the United States.

Some Previous Governmental Aid

The Government's newer rôle in materials testing had its inception in 1904. At the St. Louis Exposition the exhibit of the Association of American Portland Cement Manufacturers, under the direction of Richard L. Humphrey, attracted the attention of the late Dr. J. A. Holmes then in charge of the Technologic Branch of the Geological Survey and the associated Materials Testing Plant at Pittsburgh. Through the joint efforts of these two men a great enlargement of the field of Government testing was effected and a new day of coöperation inaugurated between the Government and the professions.

A comprehensive program, including column tests, was outlined and undertaken as early as 1905. A National Advisory Board on Fuels and Structural Materials, created by President Roosevelt, was formally organized in 1906.

Steps Toward Tests of Large Columns

The next event of importance in the history of the Government's connection with the column problem was a meeting held in New York on Sept. 24, 1907, on the initiative of the commanding officer of the Watertown arsenal. Dr. C. B. Dudley was in the chair. Reference to the series of volumes published for over 20 years by the testing laboratory of the arsenal, under the title "Tests of Metals," will show that the laboratory had, almost from the beginning, attached great importance to the subject of tests of structural shapes. A considerably increased appropriation by the Fifty-Ninth Congress had made possible an enlarged program of investigation.

The consultation in New York took place less than a month after the Quebec disaster, the shock of which was vivid in the mind of every engineer and must have made itself felt at the New York gathering.

What justifies Government coöperation in engineering research? This question met with fair discussion and a definite answer then and there, as follows: The Government is the only body with sufficient funds to engage in extensive and *disinterested* investigation; its operations may cover long periods of time unhampered by commercial testing; its conclusions are likely to be fair; it can command the coöperation of all parties; it retains or can secure the services of recognized experts.

It was decided at the New York meeting to employ the arsenal's resources in a series of tests on full-sized steel

columns. A program was laid out calling for the fabrication of 313 specimens, and this was enlarged by the advisory committee in the spring of 1908 to include high-carbon and nickel steel and additional types of section. The complete program, with 423 specimens, was the greatest ever projected.

Under the supervision of James E. Howard the work was carried forward at Watertown during 1908 and 1909, and the results were published in "Tests of Metals." Up to January, 1910, approximately 25% of the program had been executed, resulting in a valuable body of data.

But, as recognized beforehand, the capacity of the Emery machine at Watertown, 800,000 lb., imposed severe restrictions on the scope of the investigation. The preliminary New York meeting had decided that the necessities of the country demanded a machine of at least 10,000,000 lb. capacity. In time, Congress was brought to see the need, and the Geological Survey, through Dr. Holmes, was instructed to invite bids for such a machine, whose capacity was to exceed any hitherto known in this country or elsewhere. Early in 1908 the bids were in, and the contract for the 10,000,000-lb. compression machine was awarded to Tinius Olsen & Sons. By July, 1910, the greater portion of the machine was in place at the Pittsburgh laboratory of the survey.

Bureau of Standards Organizes Effort

In the meantime developments had been going on in Washington tending toward the centralization of such governmental engineering research in one organization. The underlying reasons are obvious. It was felt that the Bureau of Standards, which was definitely established for research, was the logical body to prosecute investigations affecting the public at large, rather than other bureaus in which testing was a somewhat accidental outgrowth of other work.

In this view the Congress of 1908-09 assented. An authorization was passed for the transfer of the Watertown 800,000-lb. machine to the Bureau of Standards; but this was later repealed upon representations from the Director of the Bureau, and an appropriation was substituted sufficient for the purchase of the 2,300,000-lb. Emery machine now in use in the Washington laboratory. The needs of both the arsenal and the bureau were seen to be better provided for by this arrangement. The same Congress provided for the transfer to the National Bureau of Standards of all the structural-materials testing operations of the Geological Survey, so that in 1910 the great Olsen machine in Pittsburgh passed formally into bureau possession.

By the latter part of 1912 the precision Emery 2,300,000-lb. machine was completed and in place in Washington, and the United States Government was ready to attack the column problem under suitable leadership and with the most formidable weapons in the known world.

Column Testing Has Been the Great Work of the Emery Machine

In 1909 the Column Committee of the American Society of Civil Engineers was organized. It early recognized the desirability of coöperating in a Government investigation and pointed out that the engineering profession had much to gain from an elaborate series of tests on columns of ordinary commercial size. The Bureau accepted the committee's coöperation. A program was outlined. On June 12, 1912, the committee appointed by the American Railway Engineering Association to "study the design of built-up columns" broached the project of a second series of tests of full-sized compression members to supplement the one already contemplated. This also was entered into, with enthusiasm.

Thus a great task was waiting for the Emery machine at Washington by the time it was in working order. The two investigations were instituted concurrently by the Bureau of Standards with the coöperation of the two committees. The work of testing was completed last year, save for a mass of supplementary coupon testing, which is still going on. The number of observations on each column varied from 400 to over 2000 and included compressometer, strain-gage and deflection measurements. Reports were furnished the interested societies as completed, though the Technological Paper embodying the conclusions drawn from this laborious research is still in course of preparation. Some 250 columns were tested, of every section type in common use, with values of l/r ranging from 20 to 155, giving a body of data unprecedented in volume and detail. An engineering demand has been squarely met.

The remaining columns embraced in the Watertown program—of earlier origin—were shipped to the Bureau of Standards last year, and that investigation will be completed as time permits.

Some Other Work of the Emery Machine

As illustrating the wisdom of installing a machine of the capacity of the one in Washington, certain other tests of importance may be mentioned.

A latticed column submitted by the New York Central was tested to destruction: Weight, 8283 lb.; length, 30 ft. 2 in.; cross-section, 64.92 sq.in.; radius of gyration, 7.06 in.; l/r, 52; ultimate load, 1,996,900 lb. = 30,759 lb. per square inch.

A nickel-steel bolt of 4.5-in. diameter was tested in tension for the New York Board of Water Supply. It broke at a load of 1,096,000 lb., or 113,900 lb. per square inch.

Four steel cables of 3¼-in. diameter have been broken at loads ranging from 866,000 to 962,000 pounds.

In June, 1914, a 30-ft. section of a Marconi wireless mast was tested in compression: Weight, 11,450 lb.; largest diameter, 54 in.; sectional area, 89 sq.in.; ultimate load, 1,656,200 lb. (18,600 lb. per sq.in.). The dimensions of this specimen practically coincided with the limits of the machine.

The only test that has so far taxed the load capacity of this machine was the compression of a 90-lb. glass cube representing insulation for use in the foundation of a wireless mast. With a bearing surface of 10 x 10 in. it sustained a pressure of 2,616,000 lb. without complete failure.

The features of the Emery machine which give it preference over others of like capacity for the purposes designated are the sensitiveness and accuracy of its weighing system. The load indicated by it is that transmitted to the hydraulic support by the specimen itself, friction of the piston not influencing measurements to the slightest degree.

The 10,000,000-lb. compression machine at Pittsburgh is capable of testing specimens whose least width does not exceed 6 ft. and whose height does not exceed 25 ft. It is adapted to a wide range of work. It has been used in making tests of large steel and reinforced-concrete columns, granite blocks, porcelain insulators for Marconi wireless towers, concrete piles, brick piers, monolithic concrete, etc.—in short, all types of specimens which by reason of their size and strength could not previously be tested.

Four Jacks Used

The four large jacks used in the erection of the Hell Gate arch were subjected to proof loads of 6,000,000 lb. in this machine. Valuable information was furnished for determining the most efficient type of piston packing. Several proof tests were made of a cast-iron keel block of a type used in the dry dock at the Isthmian Canal. Important data were obtained when the block was tested under various degrees of eccentric loading, corresponding to those which are liable to occur in actual engineering practice. Numerous tests have been made of steel Marconi tower sections and the insulators supporting these towers at their bases.

A systematic investigation of hollow building tile is being conducted, in which tests are made on full-size walls constructed of this material. The program provides for the testing of walls up to a height of 20 ft., under manifold variations of thickness, bond, stress application, etc.

An investigation was conducted for the State of Pennsylvania and the United States Bureau of Mines to determine the most efficient and economical type of filler material and structural bracing to prevent earth subsidence over exhausted mines—a highly vexatious engineering problem. A large number of tests have been made upon different forms of cribs and grillages in which culm, ashes, rock, sand and other materials were placed. The full 10,000,000-lb. load was usually applied, and stress-strain readings were taken for purposes of comparison. Cubes of coal up to 5-ft. dimensions, blocks of concrete, grouped columns of timber, sand, culm and ashes confined in steel cylinders—all have been subjected to tests in great number in pursuance of this investigation.

Piers and Columns

Brick piers as large as 4 ft. square have been tested in this machine. An important series of tests has been conducted during the past three years for the National Brick Manufacturers Association. The brick has so far been selected to be representative of the output of manufacturers east of the Mississippi. The effects of different mortars and bonds are being determined. Thus far, complete stress-strain data have been secured upon approximately 50 piers. A progress report of this research has been given in *Engineering News* and *Engineering Record*.

The largest reinforced-concrete column that has been tested in this machine was 30 in. in diameter and 16 ft. high. It was provided with both rod and spiral reinforcing. Several tests of columns 20 ft. high have been executed. A most important research was that conducted for the American Concrete Institute. Twenty-four columns 12 ft. high and varying in diameter from 20 to 24 in. were tested. These columns were constructed with different percentage compositions and different types of reinforcing. The primary purpose of the tests was to determine the relative efficiency of rods and spiral reinforcing. Numerous measurements were taken on the external faces and on the reinforcing material. The results have been published in the "Proceedings" of the American Concrete Institute.

Another investigation was made upon columns reinforced with hollow cast-iron cores placed concentric with the axis. These columns were approximately 12 in. in diameter and varied in heights up to 16 ft. The compressive strength in a concrete column of this type of reinforcing varied from 8000 to 10,000 lb. per sq.in. Other tests of large concrete columns have been conducted for engineers, but are not reported as research.

Steel Columns

Tests of steel columns having a cross-section as high as 110 sq.in. have been made in this machine. Some of the columns are among the largest that have yet been tested. Twenty-two bridge columns have been tested up to the present time. The test specimens are half-size models corresponding to originals in the long-span bridges at St. Louis, Metropolis (Ill.) and Memphis (Tenn.), constructed of nickel, high-carbon and various alloy steels.

Numerous extensometer readings were taken to furnish data for studying the behavior of the columns as units, and the deportment of pin plates, transverse diaphragms and lattice, together with other details. The tests have furnished further evidence to show that large columns of small slenderness ratios fail at the mean yield points of the component steel shapes. The behavior of the details has shown that it is important that a great deal of intensive experimental study should be given to determine the most efficient type of details in large members.

Value of the Large-Size Tests

The importance of investigational work of this character cannot be overestimated. Smaller machines must always contribute their share to supplementary study of engineering material, but the behavior of the structural materials in the aggregate can be properly determined only by full-size tests of the built-up structure as it is to be used under service conditions. Reliable information for framing building codes and equitable specifications can only be ascertained by tests in machines of large capacity, such as have been described.

In such manner has the Government faced the problems of the present. But there is no reason to suppose that it has closed its eyes to the future. It means to do its part, no matter how swift the growth of structural members may be in years to come.

Effect of Silt and Sand on Wood Pipe

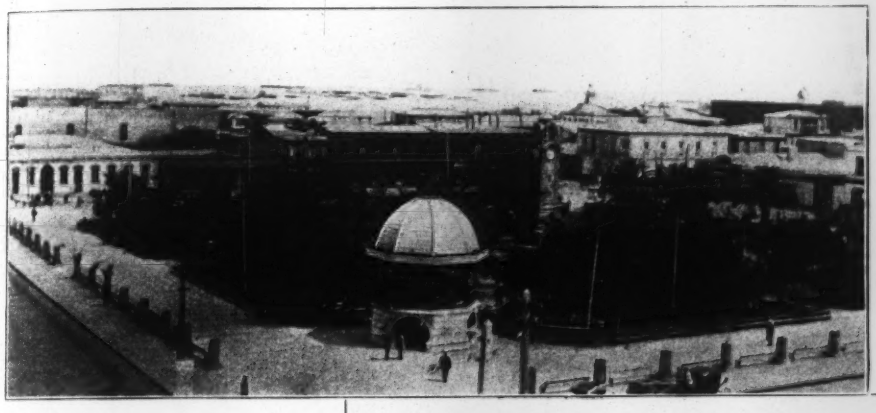
As a result of research and field tests the United States Department of Agriculture announces in Bulletin 376 that wood pipe intended to convey silty water should be designed for a working velocity of from 5 to 10 ft. per sec. A velocity of about 5 ft. per sec. will be high enough to carry out the largest part of the sand, and at the same time will not be so high as seriously to erode the pipe. It is better to provide occasional sumps for sand than to attempt to clean by excessive velocities.

Chilean City To Spend $6,500,000 for Harbor Construction

Large Nitrate Exports from Antofagasta Make Existing Port Capacity Inadequate

By FRED. McCOY
Columbus, Ind.

BY A recent act of the Chilean Congress a sum of nearly $6,500,000 was appropriated for the new harbor construction soon to be undertaken at Antofagasta, the world's principal port of export for nitrate. This product, together with 7,000,000 lb. of copper per month from Chile and small shipments of tin ore from Bolivia, represents the principal tonnage handled at present.



THE PLAZA AT ANTOFAGASTA, CHILE, AND THE HARBOR IN THE DISTANCE

PART OF ANTOFAGASTA HARBOR TO BE COVERED BY THE NEW DOCKS

As the tonnage offered for shipment far exceeds the capacity of the present port, there have developed the ports of Calita Coloso to the south and Myillones to the north, all of whose business will go to Antofagasta when the new harbor improvements are finished. At the present there are no ports where a ship may dock between Callao, 1000 miles north, and Coquimbo, 500 miles south.

Antofagasta is the coast terminus of the Ferrocarril Antofagasta Bolivia, a 75-cm.-gage road reaching the principal towns of Bolivia as well as the neighboring nitrate fields. The national railway, known as Ferrocarril Longitudinal, crosses the F.A.B. line about 60 km. inland. This is a meter-gage road running from 1200 miles south, built strictly from a military standpoint. It has not as yet developed sufficient business to pay running expenses.

The act of the national Congress provides for the expenditure of a sum not to exceed £1,700,000 (English gold) for the construction of port works, and P 300,000 (Chilean gold; $109,500) for preliminary expenses and construction of a branch of the Longitudinal Ry. to connect the port with the main line.

All lands, not only those required for the docks, but also any necessary for securing materials of construction, are to be appropriated for governmental use. Although no official plans have been made public as yet, it is understood that the works will consist of an outer breakwater, the building of concrete docks, blasting and excavating of ship channels and equipment of unloading cranes. Probably the greatest part of the work will be in excavating ship channels.

Material for breakwaters is near-by and of good grade. The principal rocks of the immediate shore are a soft fine-grained diorite, which has been split by joint planes to an approximate size of 4-in. cubes, and a rather massive diabase much resembling the rock of the New Jersey Palisades.

The town is of 50,000 population and has doubled in size within the last 8 years. Living expenses are very high as no food is raised near-by, but all is shipped in by boat from the south. The interior country is an intense desert, and the city water is brought 192 miles by pipe line from the head waters of the Loa River. Laborers receive a daily minimum of P.8 (about $1.60), and their living is of course on that scale. Americans living in ordinary circumstances pay about $5 board per day.

During the past 12 months the city has laid 10 miles of paved streets and has 6 miles under construction, with 10 miles of a seaside drive under consideration. The writer has recently been in Antofagasta and learned of the project at that time.

Seepage Water, Formerly Wasted, Now Pumped for Irrigation

Drainage from Idaho Bench Lands Forms Artificial Lake 25 Miles Distant—Pumps Lift Water to Adjacent Lands

By JULIUS HORNBEIN
Civil Engineer, Salt Lake City

MUD LAKE, formerly a natural seasonal wet-and-dry depression in the northeast portion of Idaho near the fertile valley of the north fork of the Snake River, has in recent years been filling with seepage and waste waters from the higher irrigated lands on the Egin Bench, 25 miles away. Several pumping projects have been initiated to pump to adjacent lands the water from this ever increasing supply. The scheme will provide a supply for many thousand acres of flat land immediately adjoining the lake and will materially restrict the waterlogged area.

The United States Reclamation Service found an area here of several hundred thousand acres irrigable from the north fork of the Snake River; but the cost of bringing on the water was prohibitive. The advent of a permanent growing lake in the center of the tract makes the pumping projects attractive, and the limited irrigation of tracts from water retained behind dikes when the lake is at its seasonal high stage indicates that there are no alkalies or salts injurious to the fertility of the land, despite the fact that the water undoubtedly comes from irrigated areas.

Lavish Sub-Irrigation the Supply

The irrigated section that supplies these drainage waters lies east of St. Anthony in Fremont and Jefferson Counties. Irrigation commenced here during the early nineties; and because of the extremely sandy nature of the soil, it was with considerable difficulty that enough water could be poured into the lands to reclaim them. In recent years this difficulty has been overcome, and now four large canals with capacity averaging 2000 sec.-ft. supply the water.

In the method of irrigation a wide departure is made from that generally prevailing. It is found that by simply permitting the water to flow in canals or to be collected into small individual reservoirs the necessity of flooding, or of spreading the water over the land by furrows or corrugations, is avoided. The sandy nature of the soil is such that the land sub-irrigates perfectly by this method. Despite this lavish use of water, no conditions necessitating drainage of the adjoining bench lands have arisen, so the supply seems assured.

Mud Lake was of an ephemeral nature, sometimes being completely dry, other times covering a few hundred acres of land and occasionally, after large floods of Camas Creek, submerging some 2000 to 2500 acres. About 15 years ago a change was noticed with respect to the lake. It commenced greatly increasing in size. It lost its temporary nature, no longer drying up, but each year it increased until now it covers some 15,000 acres with an average depth of about 7 ft. It is noticeable that during the spring and fall of each year is grows larger and that it recedes during the summer; but it is also observed that each year has shown a greater increase than for the same period during the preceding year.

INSTALLING ELECTRIC-DRIVEN CENTRIFUGAL PUMPS TO LIFT SEEPAGE WATER FOR IRRIGATION

Many explanations have been suggested as to the cause of this unprecedented increase in the size of the lake. One theory is that, due to seismic disturbance alleged to be contemporaneous with the San Francisco earthquake, subterranean conditions have been altered and that the subsurface flow of Camas and the other creeks, which was supposed ultimately to reach the Snake River, has been prevented from so doing and now finds its outlet at Mud Lake. However, this theory is probably more fantastic than real. That the true source of the waters is from Egin Bench is generally conceded by persons who have investigated the matter. A chain of small sloughs and ponds, whose formation has preceded or has been contemporaneous with the enlargement of Mud Lake, extends from there on toward Egin Bench and is separated therefrom only by a low ridge of sand hills. It is also found that in drilling wells in recent years the entire water plane of the country between Egin Bench and Mud Lake has risen and that where formerly water was

not to be had at a reasonable depth it is now readily obtained.

Immediately to the west of Egin Bench is a low line of sand hills. Farther to the west the soil consists of a medium clay loam of varying depths. This loamy soil is undoubtedly lacustrine in its nature and overlies a basaltic lava flow that outcrops in many places. Experience in Idaho in the construction of reservoirs in this lava formation shows it to be very treacherous and that waters stored in reservoirs find their escape through many seams, cracks and crevices in the underlying lava formation. Without a doubt such conditions occur with respect to the waters on Egin Bench; and instead of being held by the soil, there to do their destructive work of ruining fertile lands by waterlogging them, they find their way through the lava to come to the surface again at Mud Lake.

Inasmuch as the lands adjacent to the lake are low lying, situated only at a small elevation above the lake, the pumping lift is low; and with the enormous electric horsepower that may be generated on the Bear River and the Snake River, the cost of such irrigation should be small.

The Owsley Carey Land and Irrigation Co. was organized in 1909 for the irrigation of lands situated immediately to the south of the lake. It has been granted segregation for some 15,000 acres, and its application is now pending for an additioual 15,000 acres. This company has constructed its irrigation system for the first segregation.

Provide for Rising Lake

The system includes an intake canal having a capacity of 400 sec.-ft. This canal starts from the southern shore of the lake and extends southward about 1½ miles. The portion adjacent to the lake has been submerged by the continual rise of the lake. This contingency was foreseen, and spoil derived from the excavation of the canal was removed some distance from the banks to prevent any filling of the canal by such material. At the terminus of this intake canal a hydro-electric pumping plant has been installed, consisting of two 36-in. Platt Iron Works centrifugal pumps designed to be operated by General Electric motors. The total lift of these pumps is 10 ft., and each pump has a capacity of 65 sec.-ft. with such lift. These pumps discharge into a concrete-lined basin, whence the water flows into the main canal of the system, by which means it is conveyed and distributed over the lands and the project.

During the past summer the system was operated for the first time under adverse conditions, in that power was supplied by gasoline engines. The electric power for the operation of these pumps is to be derived from the Ashton St. Anthony Power Co., which is constructing on the north fork of the Snake River a large hydro-electric power plant. The construction of this plant has been delayed, and this delay has retarded the development not only of the Owsley project, but of the three remaining projects proposing to irrigate land from the waters of Mud Lake. Power is supplied by the Utah Power and Light Co. to sections not a great distance from here, yet this territory has been alloted to the Ashton St. Anthony Power Co. by the Utilities Commission of the state. For this reason the former company cannot supply power to these projects.

The Mud Lake Canal Co. was organized in 1912 for the irrigation of about 10,000 acres of land situated to the south of the Owsley land. This company has constructed an intake and distributing canals and has entered into contract for pumping equipment similar to that noted. Fred W. Kiefer, Idaho Falls, Idaho, is chief engineer for both companies.

The North Lake Canal Co. was organized for the purpose of irrigating 17,000 acres of land situated on the west side of the lake. It has been actively engaged in the construction of several miles of main canal with a steam shovel. This company proposes to raise water from 10 to 40 ft., the greater portion of the acreage to be irrigated being served by a 10-ft. lift.

To Irrigate 8000 Acres

The Crystal Lake Irrigated Lands Co. has been organized for the purpose of irrigating 8000 acres of land situated to the west of the Owsley project. During the preceding summer it commenced excavating canals. While the water-supply obtainable from Mud Lake cannot be predicated with the certainty that the discharge of streams may be measured, many competent engineers consider that it will be ample for the irrigation of a large acreage. Due to the fact that natural drainage of the lands designed to be irrigated is toward the lake, it will act as a natural reservoir for the accumulation of waste water from irrigation. It is also believed that, when any actual extensive irrigation occurs, the factor of diminished evaporation will assist in supplementing the waters of the lake. As water is pumped for irrigation, the surface of the lake will be diminished in size and the large shallow acreage will be drained, thus diminishing the evaporation loss.

Remodeling of Dwelling Houses Required By Proposed State Building Law

Practically every building in the State of Pennsylvania will have to be repaired quite extensively if a state-wide building law recently reported by a special commission is enacted by the legislature. One part of the proposed law covers dwelling houses, "prior erected" as well as "hereafter erected." For the former, many provisions are made that call for extensive reconstruction or improvement work. A specimen is section 720, which specifies that incombustible fire stops must be built in above the foundation walls to the height of the first floor, a practice not common in the older dwelling houses of frame construction.

The clause reads:

> a. Buildings of class IIIc prior erected shall be made ratproof in the following manner: The void or space usually left open between the under side of the floor of the first story and the top of the foundation wall and between the joist set upon the foundation wall shall be filled in compactly with stone, cement or concrete.
>
> b. There shall be no opening or openings in the first floor which may lead into concealed spaces in the walls or partitions above.

A clause immediately following provides that all cellars in existing houses must have concrete floors laid in them. As the law is not restricted to buildings in towns or other organized communities, but relates to cities, boroughs and townships, an enormous amount of rush work would be required if the act were passed.

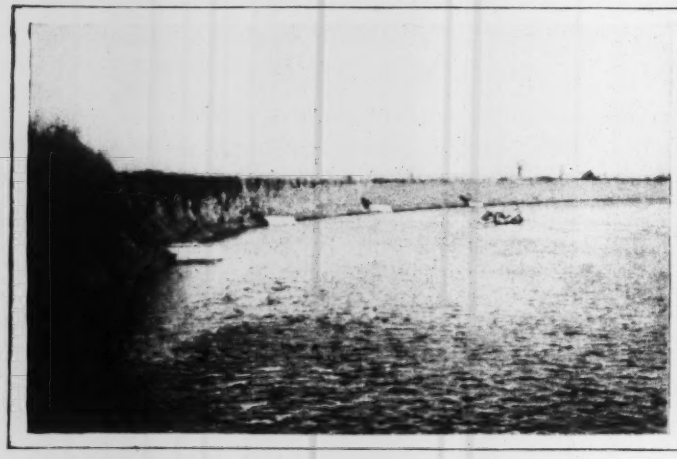


FIG. 1. GROUP OF FOUR DEAN DEFLECTORS ON COLORADO RIVER

FIG. 2. DEFLECTOR AT HIGH WATER CAUSES STILL WATER UPSTREAM

Current Deflectors Protect Banks on Southwestern Rivers

In some of the rivers of Texas and Oklahoma where great variations in water level prevail, the caving of the banks has been materially retarded by the use of the Dean deflector, shown in some typical installations in the accompanying views. This structure is a wooden frame, triangular in plan, jutting out from the bank to be protected. The vertical timbers are spiked to upper and lower sills; and the whole structure is supported above the bottom by struts, so that free flow of the river is permitted underneath the surface. Thus the water level is kept the same upstream and down and there is no eroding current around the point of the deflector. At the same time dead water is created upstream and deposition of the sediment is permitted there, creating a sloping bank.

The deflectors, which have been installed by V. G. Barr, of Oklahoma City, and which are shown herewith, have as a rule the lower sill extending several feet above the upper. They vary from 16 to 24 ft. in length, from 9 to 12 ft. in front height and 7 to 10 ft. in rear height. The sills are generally 6 x 8-in. sticks, the braces 4 x 8's and the sheathing 2 x 8's. They are built upside down on shore and launched turned over.

FIG. 3. LOOKING DOWNSTREAM AT DEFLECTOR WHICH HAS PASSED 12-FT. FLOOD

After the deflectors have been set in proper position, three 2-in. pipes are driven, one at the apex, the other two about 7 ft. back, and other pipes are driven at the rear. These pipes are to sustain the deflector off the river bed and are also to hold a small brush mattress at the rear. Stone is placed in compartments to overcome buoyancy during flood stages. The deflector is then cabled up stream and downstream to large deadmen buried back of the bank. A thousand feet can be protected for a maximum of $3000.

Inclined Track Delivers Concrete by Gravity on Street Bridge

Interesting Layout Results from Bringing in by Rail at Upper Level Materials for Structure on Bensalem Ave., Philadelphia

FOR the construction of a three-arch bridge to carry an 80-ft. street across a creek and deep ravine in the outskirts of Philadelphia the contractor built a 1-mile standard-gage railroad siding in order to bring his concrete materials to the work at high level, with a view to securing an advantageous plant layout. The bridge, which will carry Bensalem Ave. across Pennypack Creek, will have a central arch of 100-ft. span and two arches on either side of it of 60-ft. span, with massive U abutments at either end.

The U abutments and the two piers are founded on bedrock, which was found a short distance below the surface. All parts of the bridge visible from the valley below, which is park property, or from the new street, are to be finished by removing the forms while the concrete is green, and washing and scrubbing out the mortar to a depth of ¾ in., a facing mixture made with pea gravel being placed against the forms for this purpose during concreting.

The site is reached by a highway in the bottom of the valley, and some of the bidders for the work conten-

plan of using this road for the delivery of concrete materials. It would have been necessary, however, to build a hard surface, for a mile or more of it, to make the road suitable for motor-truck traffic in bad weather, and the successful bidder decided that it was cheaper to construct a standard-gage railroad siding of about the same length across fairly level farming country, with one highway grade crossing, to connect with a branch of the Pennsylvania lines. As this line ended at the high level of the proposed new roadway on the north side of the valley, it was possible to lay out a concrete plant in which the materials could be largely handled by gravity.

Mixer Located Inside Abutment

The railroad ends in a short trestle just back of the north U abutment. From this trestle, cars can be dumped or unloaded by a guy derrick set directly in line with it. Cement is stored in a house on the east side of this track and trucked to the mixing plant on a plank runway under the trestle. Sand and gravel are stored on the ground on either side of the trestle. Material cars are handled by a dinkey belonging to the contractor.

The mixing plant itself, consisting of a Haines gravity mixer mounted under hoppers of 16 yd. capacity, is located back of the face and between the walls of the abutment itself. The concrete being placed in the piers up to the springing line and in the entire south abutment is discharged into 1-yd. buckets on platform cars which run down an inclined trestle to the desired point. The two cars are attached to the ends of a wire rope passing around a large sheave provided with a brake at the head of the incline. The rope is of such length that the cars meet and pass on the turnout shown in the photograph near the middle of the trestle. The loaded car pulls the empty car up the incline.

CONCRETE MATERIALS BROUGHT IN ON HIGH LEVEL AT BENSALEM AVE. BRIDGE

Work on the south pier and south abutment is handled by a large guy derrick set just back of the front wall of the abutment, but work on the north pier and abutment has been handled by a locomotive crane running between them. This crane operates from a short track laid on the ground, and its cab will not pass under the concrete trestle. On that account, one pair of stringers and the section of track which they carry, spanning the crane track, are made up in a unit so that this section can be lifted out of the trestle by the crane, which can turn around and replace it after passing through the gap.

When the arch centers are erected and it becomes necessary to remove the concrete trestle, a high-level trestle will be built on the east side of the bridge for the locomotive crane, which will pick up buckets filled by the mixer and deposit the concrete in place. As the crane has a 50-ft. radius, it will be able to cover the north half of the bridge without moving. The concrete for the south arch can doubtless be spouted from an elevated hopper into which the crane will dump the buckets.

Unusual Surface Finish

In order to secure pea gravel without having to pay a high price for it, the contractor is screening a portion of the gravel received for making concrete. This is done by a small rotary screen fed by the guy derrick through a 10-yd. hopper. This derrick reaches both the hopper and the pile of large gravel rejected by the screen. The pea gravel runs out in a separate pile near the east face of the north abutment, and is taken to the point where concreting is in progress by wheelbarrows, or in buckets on the inclined track. The surface mortar, which is deposited behind steel plates about 1½ in. from the face of the forms, is mixed by hand near the form being concreted. It is economical to use these forms, which are raised as concreting progresses, because the pea gravel mortar is much richer than the concrete and a considerable saving is effected by making the surface coat as thin as possible.

In order to secure the pebble finish desired for the surface of this bridge, the forms are removed within a few hours if the weather is hot, or within two or three days during cold damp weather. The surface of the concrete is then washed with a hose and scraped with wire and fiber brushes, removing the mortar to a depth of ¼ to ⅜ in. and leaving the washed quartz gravel pebbles exposed. The principal surfaces to be finished in this way are vertical, and as the sections are massive the necessity for keeping the vertical depth of each day's concreting within the limit which permits stripping the forms after the concrete has taken the initial set does not reduce the rate of progress.

The bridge, which contains in all about 15,000 yd. of concrete, and will cost $200,000, is being built by Day & Zimmermann, Inc., contractors, under the direction of F. B. Maltby, engineer, for the Department of Public Works of the City of Philadelphia, of which George E. Datesman is director and Chester E. Albright, chief engineer. The work is in charge of the Bureau of Surveys, of which Jonathan Jones is engineer of bridges and John H. Hamilton, engineer inspector.

A New Evaporation Formula Developed

Empirical Statement Based on Physical Laws Agrees with Observed Facts and Is Held To Be an Improvement Over Existing Formulas

By ROBERT E. HORTON

Consulting Hydraulic Engineer, Albany, N. Y.

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A NEW and logically developed empirical formula for evaporation from bodies of water is herein presented in confidence that hydraulic engineers generally will find it a better tool than any heretofore provided for studying evaporation. Most attempts to find evaporation at a given time and place have been confined to observations of evaporometer-pan losses and inadequate formula computations. It need not be argued that evaporation needs to be better considered in many of our hydraulic investigations; we have only to realize that in summer a major part of the rainfall never reaches the ocean—disappearing into the atmosphere in a comparatively short time after precipitation.

Physics of Evaporation

Starting, as a working basis, with the fundamental principle of the "difference theory of evaporation," which is that the observed rate of evaporation or condensation from any liquid surface represents the difference in the rate of vapor emission and vapor return to the liquid surface, an effort has been made to follow out this theory to its logical consequence in accordance with the observed facts and physical principles, especially with reference to the kinetic theory of gases.

A theory or formula for evaporation should be in accordance with the following experimental facts:

1. Equilibrium or zero evaporation occurs in still air when the vapor pressure, here denoted as V, corresponding to the liquid surface temperature θ, equals the vapor pressure, v, existing in the air.

2. Evaporation continues in saturated air when $V > V_a$ where V_a is the maximum vapor pressure at air temperature, θ_a.

3. When $v > V$, condensation occurs in still air.

4. Wind increases evaporation and reduces condensation.

5. The maximum effect of wind on evaporation occurs for wind velocities of 15 to 20 miles per hour, beyond which further increase in the wind velocity does not appreciably increase evaporation rate.

6. Ebullition is a special case of evaporation where $v = V$ equals total pressure on the liquid surface, the air adjacent to the liquid being displaced by vapor and vapor removal accomplished by convection or mechanical action.

The principal processes involved in evaporation and condensation are:

1. *Vapor Emission*—The rate of emission depends on the nature of the liquid, the temperature of the liquid surface and the external or barometric pressure thereon, and is not appreciably affected by wind velocity.

2. *Vapor Removal*—This is accomplished in nature by three different processes: (a) By diffusion; (b) by convection; (c) by wind or mechanical action. In the presence of either convection or wind action, which are much more rapid processes, diffusion becomes in effect inoperative, since the vapor is removed before diffusion can produce any appreciable result. Convection, like diffusion, is probably negligible when there is relatively high wind velocity, but presents a case of considerable interest when evaporation takes place into sensibly still air.

3. *Vapor Return*—This is closely related to the two preceding processes. The rate of vapor return to the liquid surface is dependent primarily on the vapor tension over the the liquid surface and is therefore controlled (a) by the vapor tension in the air at a little distance from the liquid, and (b) by the nature and activity of the processes of vapor removal.

Old Dalton Formula Inadequate

John Dalton, in 1802, found experimentally that the rate of evaporation in still air is in accordance with the formula

$$E = C(V - v)$$

where C is a constant. It does not appear that Dalton attempted to deduce a formula including a factor for wind correction as such. However, he found[1] that a strong wind made the amount of evaporation *double* that taking place in still air. He concluded that the increase in evaporation rate was proportional to the wind velocity and included in his tables corrections to be made for a moderate breeze and a brisk wind.[2]

Following Dalton's suggestion, other investigators assumed a form of expression to represent evaporation in which the wind-correction factor, usually in the form $(1 + Kw)$, almost invariably appears as a factor by which the total measured evaporation rate in still air is to be multiplied, w being the wind velocity and K a constant.

In accordance with the Dalton formula, with the form of wind factor hitherto commonly used, the rate of evaporation increases indefinitely as the wind velocity is increased. This is obviously incorrect, since the rate of evaporation cannot in any event exceed the rate of vapor emission, and the latter is not affected by wind velocity in the absence of waves and spray. There must be for each water-surface temperature a maximum rate of evaporation, which rate cannot be increased by further increase in the wind velocity.

For the conditions in which ebullition ordinarily occurs, $v = V$ just above the liquid surface, and the Dalton formula fails in this case, since it makes $E = 0$ for these conditions.

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[1] Minutes of Literary and Philosophical Society of Manchester, 1802, Vol. 5, part 2, pp. 535-602, sp. p. 584.

[2] "Fitzgerald on Evaporation"; Trans. Am. Soc. C. E., Vol. 15, p. 588.

Some of the most elusive phenomena of nature are those involving overlapping and alternate causes such that the phenomenon may be the result of one cause under certain conditions and of other causes under other conditions, or of two or three causes coöperating. Sometimes the causes are wholly or in part mutually exclusive. The removal of emitted water vapor from a water surface is a case of combined causality. Convection and wind each operates practically to the exclusion of diffusion. Relative high wind is probably exclusive of convection also; but wind and convection may coöperate when the conditions favor the latter and the former is *slight*. These conditions make the determination of the exact expressions for wind and convection effects a difficult matter.

Wind and Convection Introduced

The removal of vapor from a liquid surface by wind action corresponds to a condition of natural exhaustion to

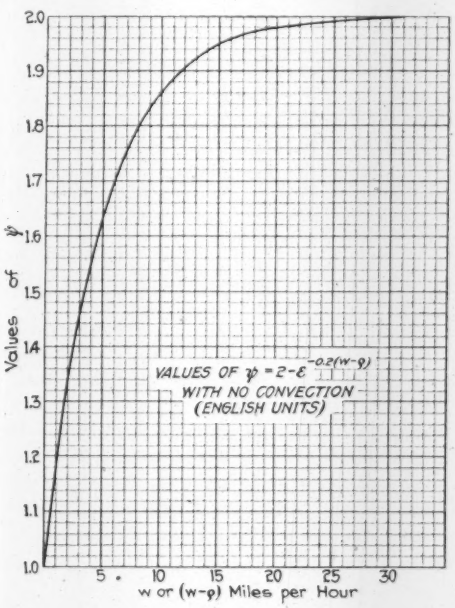


DIAGRAM OF WIND-FACTOR VARIATION

which the inverse exponential law commonly applies. Adopting this law to represent the wind factor leads to the general formula for evaporation and condensation,

$$E = C[(2 - e^{-kw})V - v] \qquad (1)$$

This formula may be considered as empirical, although it is believed to be in accordance with underlying physical principles, which, however, cannot be fully presented here.

If there is no wind, but the water surface is warmer than the air, vapor removal occurs mainly by convection. Precise experimental data relative to vapor removal by convection are wanting. However, the writer's general observation indicates that, at ordinary natural temperatures, if the water surface is warmer than the air, the convection effect is about the same as that of a wind with velocity equal to the square root of the temperature itself. If there is no wind, the quantity $\sqrt{\theta - \theta_a}$ may be substituted for w in formula (1).

There can be only positive values of this correction since convection cannot be negative. If there is a low wind velocity and $\theta > \theta_a$, the convection factor may be added to the measured wind velocity. Under ordinary conditions occurring in nature, except the case where warm days are followed by cool nights, convective vapor removal may be relatively unimportant; but it becomes important under artificial conditions where the water temperature approaches the boiling point.

Rim Factor

For the purpose of comparing the calculated with the observed evaporation from evaporometer pans, the wind factor should be further modified to allow for the reduction in wind effect by the projecting rim of the pan. This correction may be made by subtracting from the measured wind velocity a quantity ρ, the value of which is, approximately,

$$\rho = \frac{10d}{D}$$

where d = depth of water in the evaporometer below the rim of the pan, in inches, and D = diameter of evaporometer in inches.

A Working Formula for Evaporation

Let

$$\varphi = [2 - e^{-kw} - \rho] \qquad (2)$$

then

$$E = C[\varphi V - v] \qquad (3)$$

The value of the wind coefficient, k, is about 0.2. Values of the function φ may be read directly from the accompanying diagram, by the aid of which, in conjunction with formula (3), the calculation of evaporation becomes very simple. If there is no wind or convection $\varphi = 1$, and equation (3) becomes identical with Dalton's formula for evaporation in still air, in which case vapor removal takes place by diffusion.

Strictly, this formula applies only to a small element of area dA, for which $C = 0.40$, where E is the evaporation depth in inches per 24 hours. For larger areas or evaporation pans, an area factor must be introduced as hereafter described, but provisionally the value of C may be taken at 0.36 for a pan 12 in. square. The numerical factors and coefficients given are subject to revision, since with existing experimental data it is in general impossible to wholly separate the convection, rim and wind effects from the area factor.

The value of the function φ varies from unity for evaporation into still air to 2.0 under maximum wind or convection effect. It follows that according to this formula, the maximum effect of wind is to double the evaporation rate into perfectly dry air. If, however, the air is humid, the evaporation rate when subject to wind action may be several times as great as into still air having the same degree of humidity.

For ebullition, $\varphi = 2$, and $v = V$, and the evaporation rate according to formula (1) per unit of evaporation surface, whether external to or contained within the liquid, becomes proportional to CV.

Condensation occurs only when $v > \varphi V$. Thus, according to the new formula, conditions may be such that condensation would take place in still air; but if there is wind, there may be a slight evaporation instead. If, however, the humidity in the air is sufficiently large so that

$v > \varphi V$, condensation would occur in the presence of wind however great its velocity. Thus wind would tend to increase evaporation, but would tend to decrease condensation, whereas in accordance with most evaporation formulas hitherto presented the effect of wind would increase both evaporation and condensation.

The new formula is in accordance with experience, which shows that the conditions under which condensation occurs in nature are greatly restricted as compared with the conditions permitting of evaporation. Condensation or dew rarely occurs on windy nights. As a further test, experiments were made to determine the effect of wind on the condensation of moisture on the surface of cans containing ice and water, and mixtures of ice and salt, respectively. It was found under the given humidity and temperature conditions that whereas condensation took place freely on both cans in still air, the condensed moisture was evaporated from the can containing ice and water by a strong wind; but wind action was not adequate to prevent condensation on the can containing a mixture of ice and salt.

Area Factor Applied

Experience has shown that the evaporation rate from large pans is less than from smaller pans subject to the same external conditions and with the same water temperature. Engineers are generally of the opinion that the evaporation rate from a broad lake or other water surface is less than that from a small evaporometer pan exposed at the margin of the lake, the area factor or average ratio being variously estimated at from 50 to 75%. If it is assumed that a fraction, m, of the vapor evaporated from an element of area near the windward shore of a water surface is carried horizontally by wind action into the vapor blanket, as it may be called, lying immediately over the next element of surface to leeward, then it is evident that the evaporation rate should progressively decrease proceeding to leeward over a broad water surface, until the air vapor tension v reaches its maximum value for the given conditions.

It is well known that under conditions favoring evaporation on the shore evaporation still continues even at great distances from the shore over a smooth water surface in a moderate breeze. The vapor blanket referred to undoubtedly exists, however, and materially reduces the evaporation over lakes as compared with shore conditions. The thickness of the vapor blanket in the sense here used is certainly slight, so that vapor tensions or humidities as ordinarily measured, even over water surfaces, are not affected by it.

Developing the theory of the evaporation rate over broad water surfaces in accordance with formula (1), and on the assumption that a fraction, m, of the vapor is carried along the water surface by wind action, it is found that under conditions such that active evaporation occurs near the shore the evaporation rate decreases rapidly proceeding to leeward, becoming constant at some distance x_c from the windward edge of the water surface.

$$x_c = \frac{1}{mC} \log_e \frac{\varphi V - v_o}{\varphi V - v_c} = \frac{1}{mC} \log_e \frac{E_o}{E_c} \qquad (4)$$

where v_o and v_c are the vapor pressures in air at windward edge and to the leeward of x_c respectively, the latter determined as hereafter described; E_o is the evaporation rate at water's edge determined by formula (1), and E_c is the evaporation rate (constant with respect to x) to the leeward of x_c.

$$E_c = C[\varphi V - v_c]$$

For conditions such that evaporation occurs at the shore—that is, for $\varphi V > V_a$—make $v_c = V_a$ and

$$E_c = C[\varphi V - V_a] \qquad (6)$$

For conditions such that there may be either evaporation or condensation depending on the relative humidity—that is, for $V_a > \varphi V$—make $v_c = \varphi V$ and

$$E_c = C[\varphi V - \varphi V] = 0 \qquad (7)$$

In other words, the evaporation or condensation rate in this case is either zero or proceeds at a gradually decreasing rate to leeward, over the whole water surface, approaching zero as a limit. In this case x_c is infinite. For ordinary evaporation conditions—that is, $\varphi V > v$—the distance x_c is usually small and finite, generally ranging from a few inches to a few feet, so that for a large water surface the evaporation will proceed at the same rate over practically the entire water surface, the rate being

$$E_c = [\varphi V - V_a]$$

The distance x_c depends on the fraction m of vapor carried horizontally forward. The values of m have not been determined by direct experiment. They may, however, be inferred from the results and experiments on the relative evaporation losses from experimental pans of different diameters. The factor m would be unity for a perfectly uniform horizontal stream-line motion of the vapor. Its average actual value appears to be about 0.5, ranging from possibly as much as 0.6 or 0.7 for steady winds to 0.3 to 0.4 for gusty winds and becoming approximately zero over water surfaces broken by waves and over rough land surfaces or vegetation.

The constant evaporation rate to the leeward of the point x_c is independent of the factor m. In the case of an evaporation pan on shore, if x_c is less than the diameter of the pan, then under ordinary evaporation conditions the evaporation rate decreases rapidly from some value E_o at the windward edge of the pan to a value E_c at the point x_c somewhere over the surface of the pan, while to the leeward of x_c the rate remains constant.

From water's edge to the point x_c, the evaporation rate at any point x is

$$E_x = E_o e^{-mCx}$$

The average evaporation rate over a strip of unit width and length x in the direction of the wind is

$$E_{av} = \frac{E_o}{mCx}(1 - e^{-mCx}) \qquad (8)$$

Use of Evaporation Pans

Since the distance x_c is apparently relatively small in most cases, it appears that a floating atmometer exposed either near the leeward shore or at a distance of a few rods from the windward shore of a lake should give approximately the true evaporation rate over nearly the whole water surface.

The land-exposed evaporation pan appears to be about the poorest device humanly contrivable for the purpose of determining the evaporation losses from broad water surfaces. It is evident from these considerations that agreement between the results obtained from land-exposed evaporometers with different exposures or of different sizes

is not to be expected. Two evaporometers of different sizes may give nearly identical results under certain conditions, but may be widely apart under other conditions, depending on the position of the point x_c over their surfaces.

Probably the results of floating atmometers exposed at some little distance from the shore of a lake can safely be used for estimating evaporation from broad water surfaces. Even these results generally require correction for rim effect, and for difference of temperature of the water within and outside the pan.

Calculating Evaporation

Owing to the practical difficulties of so measuring evaporation as to determine the true loss from a broad water surface, it appears probable that where suitable data are available, calculation will be found more satisfactory than attempts at direct mesurements of evaporation losses. Most of the data required for calculating evaporation are contained in the annual summaries of the meteorologic conditions at regular United States Weather Bureau stations. In calculating the evaporation rate over a broad water surface, formula (5) is to be used instead of formula (1), which applies to shore conditions only. For example: Required the evaporation rate over a lake for the following conditions:

$\theta = 70°$ = water temperature;
$V = 0.732$ in. of mercury;
$\theta_a = 80°$ = air temperature;
$h = 60\%$ relative humidity.

Then

$V_a = 1.022$ in.;
$v = 0.6132$ in.;
$w = 5$ miles per hour wind velocity;
$\phi = 1.64$;
$\phi V = 1.200$;

and since $\phi V > V_a$

$V_c = V_a = 1.022$.

At the water's edge

$E_0 = 0.40[1.200 - 0.6132] = 0.2348$ in. per 24 hours.

Beyond x_c,

$E_c = 0.40[1.200 - 1.022] = 0.0712$ in. per 24 hours.

Ratio $\frac{E_0}{E_c} = 3.3$. If m is taken at 0.5, then

$$x_c = \frac{1}{0.5 \times 0.40} \log_e 3.3 = 5.97 \text{ ft.}$$

This represents ordinary summer afternoon conditions. Actually, the evaporation loss from the lake would be greater than 0.0712 in. because of the increased evaporation rate over the narrow margin to windward of x_c, because of higher water temperature on shallow shore margins all around a lake, and because winds are never steady, and a gusty wind or the presence of waves would tend to break up the vapor blanket, prevent stream-line flow of vapor, and cause the evaporation rate to approach at times the upper limit, 0.2348 inch.

For night conditions, with water warmer than the air, we would have, say

$\theta = 65°$;
$V = 0.6163$ in. of mercury;
$\theta_a = 60°$;
$V_c = 0.5170$;
$h = 0.80$;
$v = 0.4136$;
$w = 2$.

But there is convection, so that in effect

$w = 2 + \sqrt{65° - 60°} = 4.25$;
$\phi = 1.45$;
$\phi V = 0.8932$.

Again, $\phi V > V_a$, and $v_c = V_a$: $E_0 = 0.1918$ and $E_c = 0.1500$ $\frac{E_0}{E_c} = 1.28$. The average ratio $\frac{E_0}{E_c}$ for both day and night is 2.30, or the indicated evaporation over the lake is 43.4% of the shore rate. The reason for the higher night value of E_c lies in the reduced air temperature and capacity of space for vapor, hence reducing the blanketing effect. Some of the vapor emitted under these conditions is condensed a little above the water surface and carried away mechanically. Bigelow found that evaporation proceeds at night much more rapidly than is commonly believed, or than the Dalton formula would indicate.

In calculating evaporation it is always necessary to consider separately day and night conditions. Daytime temperatures may be taken as approximately one-third of the mean of the 8 a.m. maximum and 8 p.m. values, while the mean night temperature is approximately one-third the mean of the 8 p.m. minimum and 8 a.m. values. The day wind velocity is commonly about $\frac{4}{3}$ to $\frac{3}{2}$ the 24-hour mean, and the night wind velocity is from $\frac{2}{3}$ to $\frac{1}{2}$ the mean.

Difficulties hitherto experienced in reconciling observed evaporation with computed amounts as determined by the Dalton or other formulas have apparently arisen from three causes: (1) Improper application of the wind correction factor; (2) neglect of convection; (3) failure to recognize the fact that the area factor is not constant for a given size of pan or evaporating surface, but that the ratio of the average evaporation rate over such a surface to the evaporation rate at the windward edge varies with each change of meteorologic conditions.

American Cement Mill Near Guatemala City

A new cement mill with a capacity of from 50,000 to 100,000 bbl. of cement per year has just been opened about one mile from Guatemala City by American interests acting under a special concession of the Guatemalan Government, according to a recent consular report from Consul S. T. Reat, of Guatemala City. The plant has been under construction for two years and involves not only the mill itself, but two miles of railway connecting with the port. Practically all the machinery was manufactured in the United States. The new company is restricted under its franchise to a maximum charge of $4 (United States gold) per bbl. for its product. The managers state that they will be able to manufacture cement at a cost of $1.25 per bbl. and that it can be sold much below $4 per bbl. and still produce an adequate return on the capital. Before the European War most of the cement in Guatemala was brought from Belgium and Holland, and American manufacturers could hardly meet the competition. Since the war, practically all the cement importation has been from the United States, but transportation charges brought the cost in Guatemala City up to as high as $7.25 a bbl.

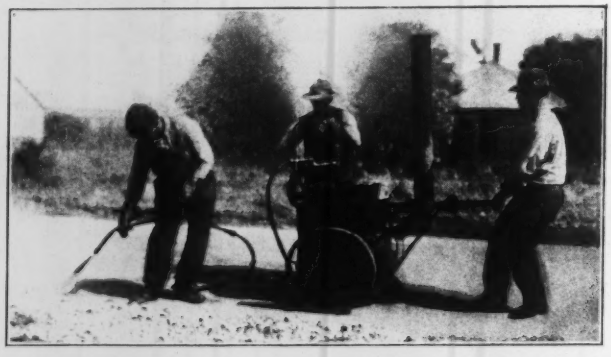
Unique Method of Handling Hot Oil on Maintenance Work

Small Distillate Burner Heats Oil in Small Buckets—Distribution Under Pressure of Hand Pump Set in a Wheeled Kettle

By H. M. LUKENS

THE Los Angeles County Highway Department has a unique system of heating and distributing oil in the maintenance of its paved ways. The oil is too cold for use when it reaches the job in trucks from the main depot. It is poured into buckets that have previously been arranged in two rows with another row on top. Wood used to be the heating medium, but recently it has been displaced by a portable distillate and water burner that has proved much more efficient. As many as 80 buckets of oil can be heated to 500° F. in about 15 min. About 15 or 20 gal. of oil at this temperature is placed in the hand oiler for direct application to the patch or street.

The hand oiler is made of sheet iron, with a boiler about 2½ ft. in diameter and about 3½ ft. high. Inside this boiler hangs a cast-iron pot of about 20 gal. capacity, the intervening space between the pot and the boiler being used as a firebox. This apparatus is so suspended on two iron wheels that the center of gravity is low enough to keep the boiler upright. On one side is riveted an iron handle with which to move it, and opposite and on top of the boiler is the hand crank for the oil pump, which is fastened to the bottom of the oil pot. The pump, of the rotary type, is driven by sprocket and chain from the hand crank and is capable of developing 6 to 10 lb. pressure per square inch. To the pump is attached 20 ft. of ¾-in. metallic hose with a piece of ¾-in. pipe 3½ ft. long at the discharge end. This end is plugged

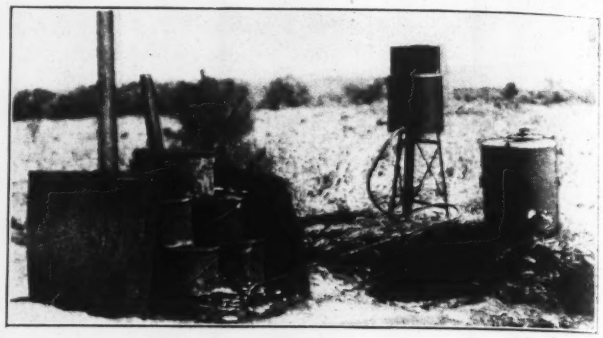


PRESSURE SPRAY NOZZLE IS EQUIPPED WITH THROTTLE

so that under pressure a spray is formed which may be regulated by a throttle.

It has been found from experience that best results are had from heating the oil to the desired temperature in the buckets and using it in the hand oiler without any additional fire in the firebox. Fire in the oiler causes the bottom of the oil pot to cake up, which in time breaks loose and clogs the pump.

The maximum capacity of the machine is about 125 gal. per hour. The amount of oil delivered per square yard may easily be regulated with a little experience. The



PORTABLE BURNER CAN HEAT 80 BUCKETS AT ONCE

man on the spray is taught to apply less than the exact amount and then to increase this quantity until he knows by actual practice the requirements.

The average repair gang consists of nine men—one foreman, one truck driver, one to push the oiler, one to pump, one to spray, and four to prepare patches. Cost data are difficult to obtain, as the expense varies with the size and proximity of the patches. On work of building out shoulders of 5-in. macadam the cost varies from 9 to 10c. per sq.yd., depending upon location.

Report on Wood-Decay Investigation

Increasing losses in the lumber industry and in various fields of use of timber have in the last few years drawn strong attention to the serious situation with respect to decay. Studies relating to fungi and decay have been started on a large scale by various lumber manufacturers' associations and by the U. S. Forest Service. The latter gives the following advance abstract of its findings during the past year:

Field and laboratory studies indicate that much more care should be exercised in the selection of timber and in the construction of buildings to avoid conditions favorable to decay. Any one of the following causes may result in rapid deterioration of the building: (1) Use of green timber, (2) allowing the timber to get wet during construction, (3) allowing the timber to absorb moisture after the building is finished because of leaks or lack of ventilation, (4) use of timber containing too much sapwood, (5) use of timber which have already started to decay. The avoidance of these conditions will, as a rule, prevent decay. In special cases preservative treatment is necessary. (Zinc chloride and sodium fluoride are better than creosote for buildings.)

Studies to determine the extent to which lumber is attacked by fungi while seasoning in lumber yards were continued. Specific cases were studied, showing how sound lumber is infected by partly decayed lumber before shipment is made. Simple rules were formulated for restricting the spread of fungus in lumber.

Tests to determine the effect of various amounts of resin in the southern pines upon their durability indicate that it does not depend directly upon their resin content.

About 1500 pieces of wood, representing 50 different species, are under test to determine their relative durability. At the end of three years, all of the conifers with the exception of cypress, redwood, yew, and the cedars, have decayed, as have also most of the hardwoods.

Tests Show What Parts of City Streets Are Used by Traffic

Vehicles Do Not Distribute Themselves Evenly Across Roadway, but Seek Zones of Least Resistance, According to Results

By H. T. HUTCHINS

Assistant Engineer, Department of Public Works, Borough of Manhattan, New York

IT IS a matter of everyday knowledge that traffic does not use the full width of a street. The section near the curb is very often kept from average use by standing lines of vehicles, and very often street-car tracks will cause a diversion of traffic from or to them, depending upon the relative smoothness of pavement between rails and the rest of the roadway. A study of this distribution was made on certain streets in New York City, and the following analysis will in some ways discredit the ordinary method of rating traffic as in tons per day per foot width of roadway.

Roadway Marked Off

In carrying out this study the roadway was marked off in divisions 2 ft. wide from one curb to the other. The type of the vehicle and the division through which one wheel of the vehicle passed were noted, and from these data the amount of roadway covered was laid off on a chart in the office, a line representing the width of each vehicle. From this chart the number of vehicles passing over each section of the roadway could be counted and a curve drawn which would show the number of vehicles in each section.

Vehicle Path

The type and condition of paving, the presence of car tracks, and vehicles standing at the curb affected the results materially. In one instance where the space between the tracks was paved with new granite block, while the remainder of the street was covered with uneven blocks laid on a sand cushion, the drivers of vehicles sought the smoother surface of the street-car area and in many instances drove their vehicles directly upon the girder rails. Fig. 2 is a graphical representation of this case.

In another instance where there was no perceptible difference between the character of the pavement between the car track and the rest of the street, distribution was very much better, drivers showing no tendency to seek the tracks to the neglect of other parts of the roadway. In fact, it may be said that drivers shun the street-car area if the rest of the roadway is in fairly good condition. The necessity of turning out from the gutter or curb for even one automobile or vehicle per block has a similar effect and will throw the greatest weight of traffic into a well-defined and limited area. On streets without car tracks considerable use is made of the central portion.

Fig. 1 shows traffic taken for one hour, from 11 a.m. to 12 noon, on Lafayette St. near Duane St. There are no car tracks, and there were no standing vehicles on the right side of the street, and only a few on the left side. While the southbound traffic predominated, there was traffic over the entire surface of the street, reaching

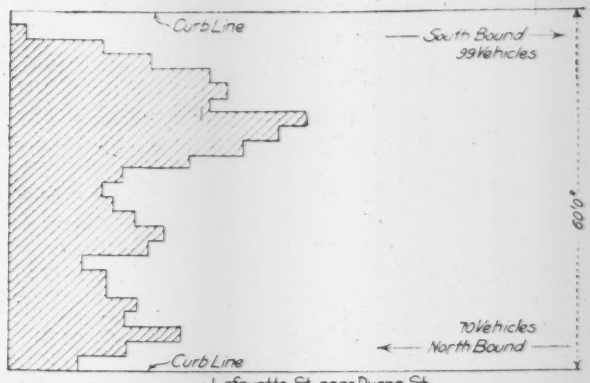


FIG. 1 Lafayette St. near Duane St. April 27, 1915 $11^{00}-12^{00}$ M.

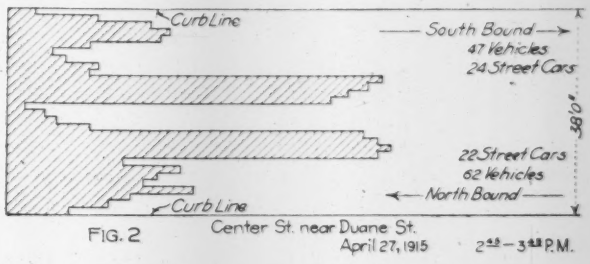


FIG. 2 Center St. near Duane St. April 27, 1915 $2^{53}-3^{53}$ P.M.

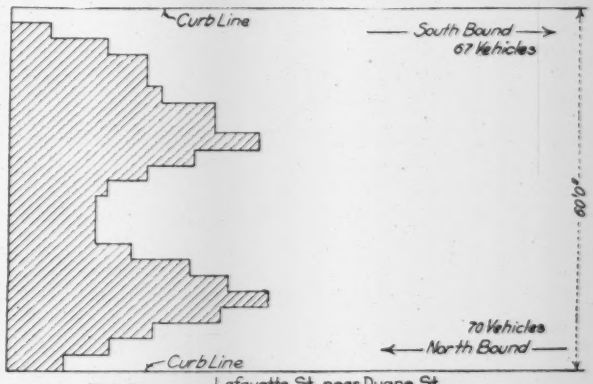


FIG. 3 Lafayette St. near Duane St. April 27, 1915 $4^{53}-5^{53}$ P.M.

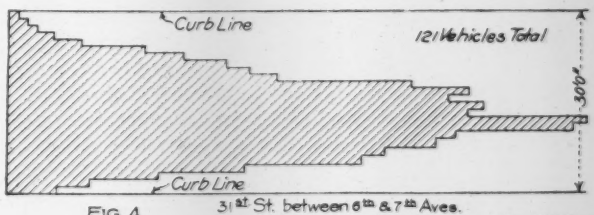


FIG. 4 31^{st} St. between 6^{th} & 7^{th} Aves. April 29, 1915 $3^{32}-4^{12}$ P.M.

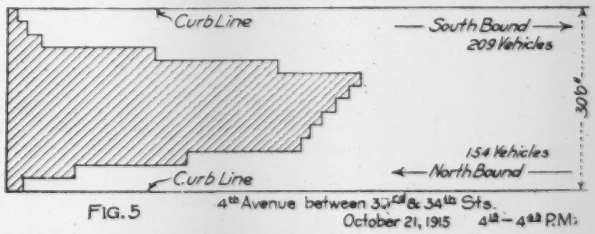


FIG. 5 4^{th} Avenue between 33^{rd} & 34^{th} Sts. October 21, 1915 $4^{12}-4^{42}$ P.M.

PLOTTING THE TRAFFIC SHOWS CLEARLY THE EFFECT OF VARIOUS FACTORS ON DISTRIBUTION

its greatest density about one-third of the way between curb lines. There is a division of northbound traffic, part of which turns into Lafayette St. from Duane St. and keeps near the curb and part of which comes direct from Center St. and keeps in the center of the street.

Fig. 2 shows traffic for one hour, from 2:45 to 3:45 p.m., taken on Center St., between Duane and Pearl Sts. Here there are double car tracks, and the granite pavement at the sides was old and somewhat rough, so that traffic sought the car-track area.

Traffic was taken from 4:30 to 5 p.m. on Lafayette St., and Fig. 3 shows the points of maximum travel at about one-third of the distance between curbs.

Parked Vehicles Force Traffic Out

Traffic taken on 31st St. between Sixth and Seventh Aves. from 3:30 to 4:15 p.m. illustrates the effect of vehicles standing at the curb, as during the entire period there were vehicles on the left side, crowding traffic over, as shown in Fig. 4. This street has no car tracks.

Fig. 5 shows traffic taken on Fourth Ave. between 33rd and 34th Sts. This is a 30-ft. roadway, carrying a large volume of traffic, which is forced toward the center by standing vehicles.

It is evident from these diagrams that traffic is not evenly distributed over the entire surface, but that it is largely affected by other factors, such as street-car tracks, kind and condition of pavement surface and presence of vehicles standing at the curb. The width of the street is also a factor, as on wide streets two distinct traffic maximum points at about one-third the distance from curbs appear, while on narrow streets the maximum travel is more central.

Ridge Relocation for Ozark Roads

EXTENSIVE road relocation is said to be necessary in southern Missouri in the Ozark Hill country. The School of Mines and Metallurgy of the University of Missouri, in a new publication, "Road Problems in the Ozark," by Prof. E. G. Harris, presents the argument for relocation very strongly. The conclusion is drawn that the main roads should in general be on the ridges.

Says Professor Harris: "On most of the roads in the Ozark Hills the first and greatest need is proper relocation. There is no reason why the cost of relocation should be feared. Engineering difficulties are small, but the need of engineering judgment is of first importance."

Professor Harris attacks the practice of leaving road-location questions to the initiative and judgment of the local residents. These, he says, are naturally prompted by selfish interests, yet on the other hand petitions from such sources are seldom rejected by the county court. He proposes that a competent highway engineer in every county should be the prime controlling and initiating power in this matter. With respect to principles governing relocation he says:

"Beyond all question the main arteries in the highway system of the Ozarks should be on the ridges. Here the first cost and cost of maintenance will be least. The main ridges are straighter than the valleys. The market places, with few exceptions, are on the ridges. Ridge roads are more accessible to residents on either side than would be a road along one side of a river. Frequent bridging of the larger streams cannot be considered at present."

Would Not Build Railroad Embankments Much If Any Above Final Grade

CONCLUSIONS relative to the shrinkage of material in new railroad embankments, recommended by the Committee on Roadway, were adopted at the recent convention of the American Railway Engineering Association. They set forth that there should, in general, be little or no allowance in height, but that an extra width of shoulder should be placed, varying according to the anticipated shrinkage. The conclusions are as follows:

In determining the allowance for shrinkage to be made in a fill, it should be remembered primarily that it is easier to add to the height of a fill that settles than to lower the track, if the settlement does not amount to as much as that anticipated in the original allowance. Therefore, unless the shrinkage of a material is well known in the conditions under which the fill is made, it is best to be well on the safe side; that is, little or no allowance should be made in height, the extra material, when possible, being deposited where it will be conveniently available for raising the track as required.

How Material Affects Shrinkage

Material used in fill varies in shrinkage from non-disintegrating rock or gravel, which gives the least, to certain swelling clays, which give the greatest shrinkage in both compactibility and erosion at the slopes. While vegetable loam has a larger percentage of actual shrinkage, it so quickly produces a protection cover of segregation that the shrinkage due to erosion is usually small. Where frozen material must be used in making a fill, heavy settlement must be expected; and this is to be avoided where possible.

The material and contour of the ground supporting the fill are also matters of prime importance, especially where unstable material is encountered. The method of making the fill should also be carefully considered. When the tracks are being raised under traffic, the vertical shrinkage will be largely taken care of in the course of the work. When the fill is made by teams, or by such means as reasonably to tamp and compact the fill in thin layers as it is made, the same is true. Where, however, the fill is made by trestle and without puddling or other method of compacting, the settlement is likely to be considerable.

Allowances To Be Made

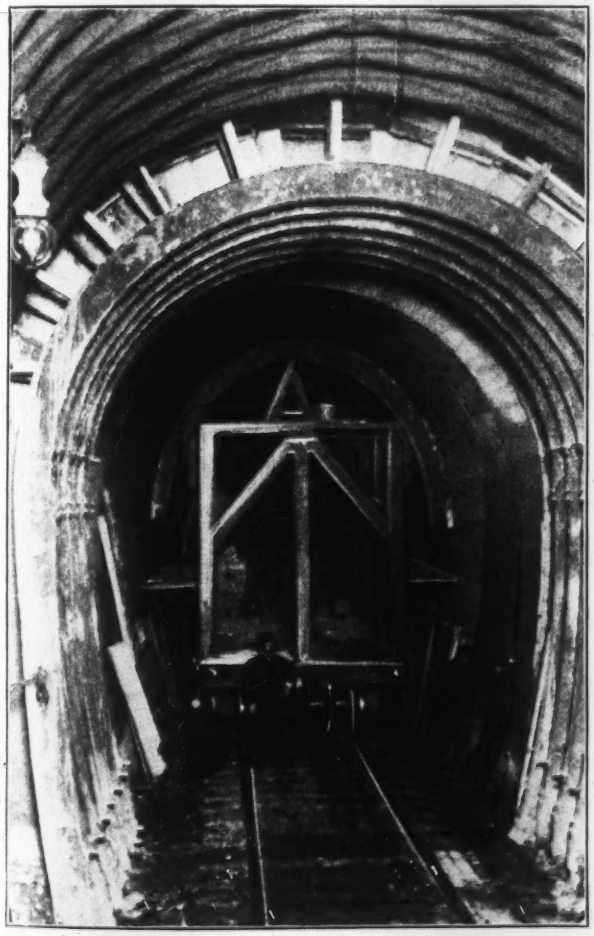
The following allowances should be made for increased width of embankment 50 ft. or more in height: For an anticipated shrinkage of 7%, add 10% of the vertical height of each shoulder or fill; for an anticipated shrinkage of 10%, add 15% of the vertical height to each shoulder of fill; for an anticipated shrinkage of 15%, add 22½%. If these allowances are made, there will be the proper bank and shoulder after shrinkage has occurred to rebuild the subgrade to its normal section and permanent standard width without widening the entire embankment. Each case should be decided on its own merits and depends on the nature of the material and manner of placing it. It is felt, however, that no embankment 50 ft. or more high will be constructed in any other manner than by dumping from a trestle, and the figures are recommended as applicable especially to this method of placing an embankment.

Special Cars and Heavy Forms Used to Reline Tunnel Between Trains

Car Traveling on Single Tracks Picks up Form Ribs and Carries Them Ahead to New Location—Concrete Placed by Separate Car

A SPECIAL concrete car with a high platform and a short tower, a jacking car for moving ahead the heavy forms, and work cars for removing the old timber lining and stone packing behind it, are being used in relining with concrete a single-track tunnel 5023 ft. long on the Union Pacific System at Aspen, Wyo., where about 20 train movements take place in the 10-hour day.

The tunnel being through material that exerts considerable pressure on the lining, the forms, made of 12-in. I-beams shaped to the tunnel section and spaced 24 in. apart, are set up first, and the roof load is transferred to them before the old timber is removed. There is a joint in each rib at each side on the springing line between the arch and post sections. To move the ribs forward, a jacking car is spotted at the right point under the roof, and the arch rib is raised from the legs slightly by taking a strain on a double-acting ratchet jack on the car. The legs are released and moved to the next location, the arch section is lowered till it clears the sides and top of the other ribs, and the car pinched ahead till the arch ring can be adjusted and bolted to the legs in their new location.



PLATFORM CAR ERECTS AND MOVES HEAVY FORM RIBS ON UNION PACIFIC RAILROAD TUNNEL

The platform car shown in the photograph is used in erecting these ribs, placing the reinforcing and removing the timber and old packing behind it. The platform is extended by hinged wings attached to the sides of the car, thus providing working space for the entire width of the tunnel. The wings are folded down when moving the equipment.

Special Car Places Concrete

Another special car is in use placing concrete. On it are mounted a ¼-cu.yd. Smith mixer and a concrete hoist, driven by motor, with a bucket holding one batch. The hoist elevates concrete to a platform 6 ft. below the crown of the arch. From this position it is spouted to place until the level of the platform is reached, after which shoveling is necessary. This car also carries water tanks and the cement. Aggregates are supplied in gondola cars and are handled by wheelbarrow.

By working three openings 200 ft. apart it is possible to keep one gang of men continually employed in form-rib erection, timber removal and excavation, while another gang is busy at concreting. At the same time the carpenters are building forms in the third opening. In this way each unit of the equipment works independently, the sequence of operation in each cycle is maintained at each point, and the work is all carried forward in one direction. The tunnel reconstruction is being carried on by forces of the Union Pacific System, of which R. L. Huntley is chief engineer; W. R. Armstrong, engineer of maintenance-of-way; G. J. Adamson, division engineer; and E. T. Hocahner, field engineer, in charge of the work.

Majority of a Minority Can Have Its Way

By the provision of the hard-surface road law recently enacted by the Legislature of Kansas, the resident property owners in a county define by petition a benefit district, the width of pavement and the type of surfacing desired. If this petition is signed by 35% of the resident land owners owning 51% of the acreage, or by 51% of the residents owning 35% of the land, or by owners of 60% of the land in the benefit districts regardless of number of residents, then the county commissioners are obliged to order the improvement.

After any Federal, state, or other aid is deducted, 25% of the cost is apportioned to the benefit district, 25% to the township and 50% to the county at large. Serial bonds running from 10 to 20 years may be issued to cover the cost of the work, and a road tax must be levied each year sufficient to retire the bonds falling due that year and pay the interest on the balance. Furthermore, a petition of 20% of the resident landowners in the county can force an election to vote on a bond issue for a county system of roads.

The building of a short section of road in a regularly constituted district, therefore, would have a tendency to force the construction of hard pavement over the entire county, since the benefited district gets practically the full benefit and pays less than one-half of the cost of the improvement.

Car-Mounted Gun Reduces Coast Defense to Engineering Problem

Located Along Existing Railways, 400 Concrete Bases on Which Gun-Cars Could Be Run and Locked Would Protect Coast

HEAVY artillery fired from railway cars, already successful in Europe, may be utilized, according to plans submitted to the War Department, to defend our Atlantic Coast, at a total cost considerably below the expense of building a single battleship. The application of such guns to coast defense, where moving targets that must be fired at through a considerable angular range are involved, presents a different problem from the use of cars of this kind in land attack. This problem is thought to be best solved by locking car and gun into a concrete emplacement of sufficient size to absorb the recoil of the gun when fired from any angle with the axis of the car. Other schemes proposed for using these guns, such as pointing them in azimuth by moving them around a circular track, have raised civil-engineering questions as to the relative speed and economy of construction necessary for the different systems proposed and the allied surveying problem of range finding with the two types of emplacement.

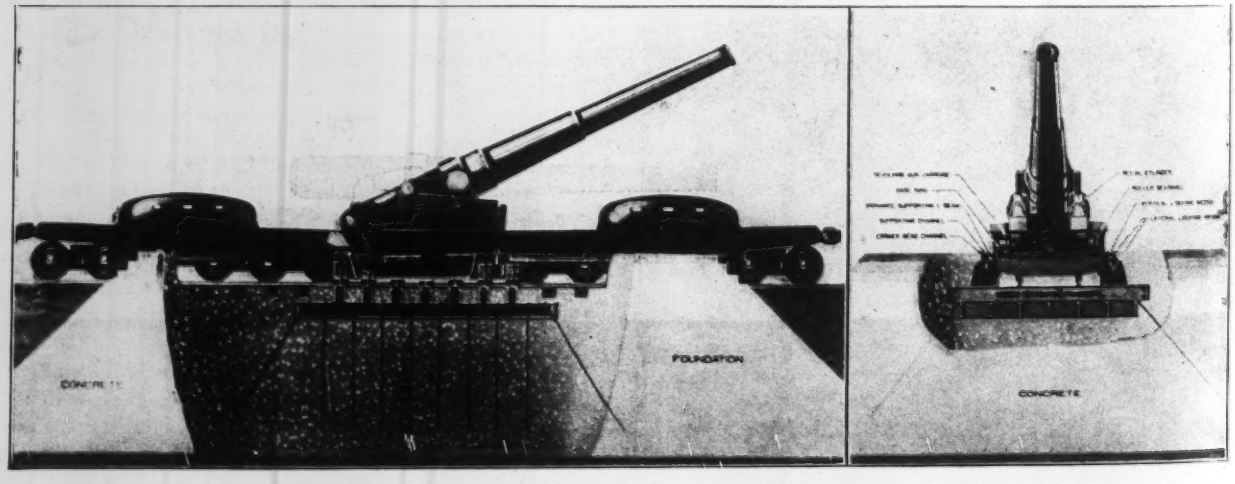
Scheme Suggested Two Years Ago

Firing heavy coast-defense guns from railway cars was first suggested to the War Department by L. W. Luellen and C. F. Dawson, New York manufacturers, who were subsequently allowed claims for patents covering the invention of car-mounted guns to be fired from concrete emplacements or to be fired in line with the car and allowed to recoil on additional supports along the track. Since then, guns of 12-, 14- and even 16-in. caliber, mostly designed according to the latter plan, have been successfully developed and put into service by France in the European War. As at first used abroad, large guns mounted on railway cars took up the recoil by sliding along the track, heavy brake shoes, engaging extra I-beam rails of special section laid outside the regular rails, being employed for this purpose. It is stated that with this arrangement the gun cannot be turned at any appreciable angle with the long axis of the car in firing.

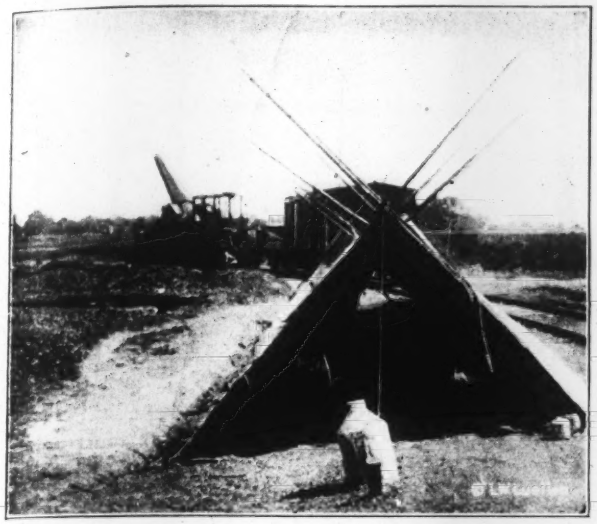
It has already been found, however, that even with guns as small as 6 in. no outriggers or other arrangements short of a permanent foundation can be devised to prevent the recoil, when firing broadside to the car, from disturbing the position of the entire mounting and seriously affecting the accuracy of the fire. The large guns mounted to recoil along the track, therefore, are fired from a circular section of track, which permits their being aimed within a given sector by moving the car along the track. Since the targets at which these guns fire in land operations are fixed, the range-finding problem is greatly simplified and there is plenty of time in which to set the car and lay the gun. It is reported, however, that a very well constructed and well ballasted track on firm ground is required for such a mounting. This track, appears from photographs that have reached this country to be at least as good as main-line railway construction in the East, and it requires in addition the outside special-section rails for the bearing shoes of the car.

Fixed Emplacements Cheaper Than Tracks

It appears that for firing a 12-in. gun so mounted through a sector of approximately 180 deg., which would be necessary in coast-defense work, some 1500 ft. of track on a radius of about 1000 ft. would be needed. Such track, including plain grading and ballast, which would be essential, and including the extra rail section, which is about equivalent to a 10-in. I-beam, might cost about $10 per ft., if laid with 90-lb. rail according to American standards. Moreover, curves on existing railways could not be utilized, because the superelevation would interfere with aiming the gun. A concrete emplacement sufficient to take up the recoil from a 12-in. gun under ordinary soil conditions would be roughly 22 x 64 ft. in plan, contain about 450 cu.yd. of concrete and approximately 4 or 5 tons of anchor bolts and I-beam reinforcement. Such emplacements would cost to build, it is estimated, from $5000 to $12,000, depending on the location and other variable factors. Because of the far greater speed in firing, it is estimated that a gun mounted on such an emplacement would be as effective as several such guns fired from circular tracks, disregarding the



FOURTEEN-INCH CAR-MOUNTED GUN PROPOSED FOR COAST DEFENSE COULD BE LOCKED IN EMPLACEMENT AND PUT IN ACTION WITHIN FEW MINUTES OF ARRIVAL AT SCENE OF ACTION



MEN ARE NOT NEAR DURING DISCHARGE OF SLIDING-RECOIL GUN

CAR FOR 14-IN. GUN, BORNE ON HEAVY SHOES, RECOILS ABOUT 4½ FT.

CREW STAYS WITH 16-IN. CAR GUN, LOCKED IN CONCRETE MOUNT FOR FIRING

Photographs, taken from official motion pictures of the French War Department

greater accuracy of fire to be attained from an emplacement.

From motion pictures of railway artillery which have reached this country, it is apparent that the car guns allowed to recoil along the track take several minutes between shots, owing to the necessity for moving the car after each shot, uncoupling and taking away the supply cars and removing the gun crew entirely from the car when the piece is fired, which is apparently required by the uncertainty as to the stability of the mount and by the severe shocks produced. Photographs of guns of equal or larger caliber fired on the French front from cars locked in fixed emplacements show the entire crew standing on the car and gun carriage while the piece is being discharged.

It has been argued that circular tracks for firing railway-mounted guns could be constructed at numerous level locations on our coast in a very short time in emergency. Those who do not agree with this contention, however, point out that a first-class roadbed cannot be built in this way and that a temporary track thrown down on the ground could not be used to support heavy artillery during firing. Furthermore, while many locations would favor hasty construction, a larger part of our coast line would require very heavy grading to put in such tracks at the required points. It would appear, according to these arguments, that since advance construction of some sort would be required in any case, the emplacements, being cheaper than circular track, would be preferable.

Range Finding and Fire Control

There are other reasons, however, why the emplacement mount is preferred by coast-artillery officers who have studied the problem. Artillery officers of the former Department of the East have worked up a simple method of range finding for car guns locked in concrete emplacements and fired at any angle. By this means the car guns would be made as effective and could be fired as rapidly as guns mounted in permanent emplacements in our coast fortifications.

With the circular track the gun must be moved before it can be aimed. The probable position of the target must be calculated a good many minutes in advance; the position on the circular track for the car, so as to bring the axis of the piece within a few degrees of being in direct line with the target, must be figured; the car must be moved to that location; and then the usual process of determining the range and training the piece begins. Should the target change its course in the meantime, the whole performance must be repeated.

Mobility of Big Guns

While it has already been demonstrated that large guns mounted in this way can be transported over ordinary railroads, it should be mentioned that the estimated weight of the 12-in. coast-defense gun, including its car mount, is about 150 tons, which, with a 56-ft. car on 12 wheels, could be transported practically anywhere in the eastern section of the country. The 14-in. gun so mounted would be considerably heavier, possibly exceeding 200 tons, and would require four 6-wheel trucks. The over-all dimensions of both can be kept well within clearance limits now standard for American railways.

Plans for such coast-defense guns have been under consideration by the Ordnance Department of the United States Army. They have been developed so far by L. W. Luellen and Cecil F. Dawson, with the assistance of United States Army officers and of a number of civilian engineers who have developed solutions to the civil-engineering and construction problems involved.

How Much Water Should Be Used in Road Concrete?

Proper Water Content for Road Concrete Found To Be Somewhat Greater Than That Giving Maximum Strength

As a preliminary result of a number of tests now being carried on in the Structural Materials Research Laboratory of the Lewis Institute, at Chicago, Prof. Duff A. Abrams has concluded that the proper amount of water to use in concrete to be placed in concrete roads is slightly more than the amount that will give a maximum strength. This is because the maximum-strength content gives a consistency that is too difficult to work, and a balance between strength and operating facility has to be made. The results of this part of the research are reported in *Concrete Highway Magazine* for April, 1917.

Tests were made on a number of 6 x 12-in. compression cylinders, made in mixes ranging from one part cement and nine parts aggregate to one part cement and two parts aggregate. The aggregate consisted of a mixture of sand and pebbles graded in size from the finest particles up to 1½ in., and the same grading was used throughout.

The tests show that the effect of proportional changes in the mixing water is approximately the same for all mixes of concrete. Therefore a composite curve was drawn to show the average effect. This curve is reproduced herewith. In it the ordinates represent the relative strength of concrete expressed as a per cent. of the maximum that can be secured from a given amount of cement and the same aggregate. The abscissas indicate the relative quantity of water used in the mix, considering the amount that gives the maximum strength as 100%. It will be noticed that there are no definite figures given, because the proper amount of water varies with the method of handling and placing the concrete, the condition of the aggregate, the temperature of the outside air and a number of other factors.

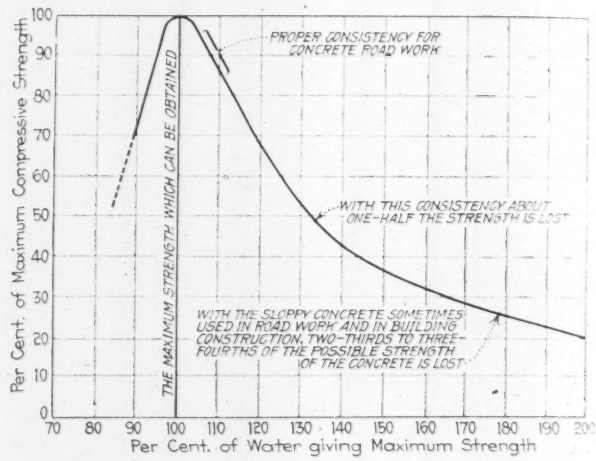
Why Road Concrete Should Be Slightly Wet

As a rule, the amount of water that gives the maximum strength produces a mix that is too stiff for most purposes, though in cast-concrete products a mix even drier than that which gives the maximum strength is sometimes desirable, because the molds can thus be removed within a short time. The general conditions, however, are shown in the curve. It will be observed that concrete strength increases rapidly with the quantity of water up to the optimum condition. With any further increase in the amount of water there is a rapid falling off of the strength, so that with an amount of water about double that required for the higher strength the concrete has only about 20% of the maximum strength.

In building concrete roads, Professor Abrams considers that it is necessary to mix the concrete a little wetter than that giving the maximum strength, and that the consistency which should be aimed at corresponds to about 105 to 115% of that giving the strongest concrete. The economies resulting from handling the concrete are more important than securing the maximum possible strength for a given amount of cement. It has been observed that many road contractors insist on using water varying between 130 and 200% of that corresponding to the highest strength, with the effect on the strength noted in the curve. Had this curve extended beyond the 200% water, it would have been practically flat, thus indicating that the maximum of damage is caused at that point.

Professor Abrams further says that questions often asked are: What is the proper consistency for concrete road work, and how is this consistency to be determined? These may both be answered by saying that for road construction the concrete should contain the smallest quantity of water that will produce a workable mix. It is evident that there may be a difference of opinion as to what constitutes a workable mix. But any reduction in the quantity of water within the range which should be aimed at in concrete-road construction is accompanied by a rapid increase in the strength of the concrete.

The proper quantity of water will vary with the quantity of cement and the size and grading of the aggregate,


Per Cent. of Maximum Compressive Strength
Per Cent. of Water giving Maximum Strength
PROPER CONSISTENCY FOR CONCRETE ROAD WORK
THE MAXIMUM STRENGTH WHICH CAN BE OBTAINED
WITH THIS CONSISTENCY ABOUT ONE-HALF THE STRENGTH IS LOST
WITH THE SLOPPY CONCRETE SOMETIMES USED IN ROAD WORK AND IN BUILDING CONSTRUCTION, TWO-THIRDS TO THREE-FOURTHS OF THE POSSIBLE STRENGTH OF THE CONCRETE IS LOST
0 10 20 30 40 50 60 70 80 90 100
70 80 90 100 110 120 130 140 150 160 170 180 190 200

HOW EXCESS WATER AFFECTS CONCRETE STRENGTH

and to a less degree with the nature of the aggregate. The water required for a sand and crushed-stone aggregate is not appreciably different from that required of a sand and pebble mixture, provided the grading of the aggregates is similar.

There is no direct criterion for determining in advance the best quantity of water for concrete being placed on a road. The concrete should be mixed so that only a small quantity of free water will appear on the surface after leveling and striking off, which gives concrete of a jelly-like consistency.

WATER REQUIRED FOR ROAD CONCRETE

Mix — Volume of Aggregate After Mixing: Cement	Approximate Mix as Usually Expressed — Aggregate: Cement	Fine	Coarse	Water Required (Gallons per Sack of Cement): Minimum	Maximum
1	5	1	2	4	6
1	4½	1	2	3	5½	6¼
1	4	1	1½	3	5½	6
1	3	1	1½	2½	5	5½

The principal difficulty in the way of attempting to determine in advance the proper quantity of water is due to the fact that aggregates are generally damp, and the degree of dampness is not uniform. In the case of concrete made of sand and pebbles, or sand and crushed stone, well graded in sizes up to 1½ in., the accompanying table indicates about the quantity of water that should be used for the mixes commonly employed in concrete roads. It is assumed that the aggregates are in a room-dry condition, which does not always prevail in work

Road Construction Costs Lowered By Close Attention to Details

An Understanding of the Peculiarities of the Subsoil Often Aids in the Selection of Equipment

By LESTER H. MORRIS
Cupertino, Calif.

THE first requisite of a good concrete pavement is a sound subgrade, and the basic quality of a sound subgrade is a uniform texture of its components. To secure satisfactory and acceptable results at the lowest cost, this last point must be kept constantly in mind, no effort being spared to reach as near perfection in each step of the work as is possible. Any lack of uniformity will result in shrinkage, which will require re-rolling—

CAREFULLY SET HEADER BOARDS HELP KEEP CONCRETE YARDAGE TO SPECIFICATIONS

or if this is neglected, it will manifest itself as a crack in the finished pavement, and injure the reputation of the builder.

In the destruction of the existing roadway a type of scarifier should be selected with which a uniform depth of disturbance may be maintained. This is best effected by adjusting the teeth to the inequalities of grade by means of levers fulcrumed on a wheel-carried frame. The market offers a range of this type of machine varying from extreme lightness to a combination grader and scarifier representing extreme stability. But irrespective of type, the work should proceed in a manner that will destroy the maximum of large lumps and clods. An orchard disk will be found very useful for completing the work.

In making fills the best results have been attained by limiting layers to one foot in thickness, by a liberal use of water, by spreading going and returning teams over the entire width, and by rolling. For fills of two feet to six feet, diking and flooding is employed, seepage to undisturbed ground being thereby secured. For depths greater than six feet, a winter's rainfall is necessary to secure a complete settlement.

A string stretched between nails driven in opposite grade stakes will enable a skillful operator to blade within $\frac{3}{4}$ in. of the bottom edge of the header boards. Each header zone and the foot outside should then be wet and rolled in order that the stakes to which the header boards are nailed may be properly supported. The header boards act as forms for the concrete, mark the finished surface of the paving, and are guideways for the proper elevation of subgrade. It is therefore important that they be carefully set and maintained to true grade by nailing them to 16-in. stakes set about seven feet apart.

Before using the shaper-templet, the area inclosed by the headers should be as completely pulverized as possible, and reduced to a uniform texture by sprinkling lightly and harrowing until mealiness is effected. This will assist in securing a true surface. In using the shaper-templet it is essential that each end shall be constantly in contact with the header boards, and that its shoe shall conform closely to the required curve of the finished subgrade.

When the subgrade has been properly harrowed and brought to the desired contour, it should be watered sufficiently to insure that the moisture will penetrate to the undisturbed soil. Unless this is attained, no bond will be established. Uniformity of sprinkling is necessary, and the best results are secured by a double application. As a preparation for rolling, a light harrowing, as a slight crust is forming, is excellent. Its tendency is to further pulverize the subgrade and reduce any non-homogeneous elements or inequalities of moisture. Experience is the best indication of the precise moment to begin harrowing. At least a ten-ton roller should be used as soon as the subgrade has dried sufficiently so that it will not "pick up" or "wave." Twice over will usually produce an unyielding surface, which may be made still harder, and sealed, by sprinkling for a few days. Once sealed, maintenance must be kept up by sprinkling at intervals of a few days, depending on the weather, until covered with concrete.

A low subgrade may be traced occasionally to a variation in the coefficient of compression of the soil. This is best remedied by thoroughly scarifying to a minimum depth, after which more earth is thrown on, and the shaper-templet, adjusted for the estimated shrinkage, dragged over. Rain for a week or ten days is a feature of most California paving jobs. The tendency of the beating and soaking is to make a subgrade still harder. It is excellent policy to roll all sections that are ready when advance information of rain is received from the Weather Bureau.

Deep Side Ditches Are Dangerous

The records of the Iowa State Highway Commission for September, October and November, 1916, show that 353 automobiles turned turtle, resulting in five deaths and 451 injuries. Just how many of these accidents were due to cars slipping into deep ditches is not stated, but this is generally regarded as the usual cause of overturning.

Large Field Drilling and Riveting Job on Union Arcade Steelwork

To Add Two Stories, Half-Erected Framework Was Reinforced by Adding Cover Plates

THE decision to add two floors to the Union Arcade Building, Pittsburgh, after the steel frame was erected to the sixth floor, presented the alternatives of dismantling the steel already erected and returning it to the shops for remodeling or of undertaking the required reinforcing of the columns in place. The latter plan was adopted, although if it had not been for the fact that some of the tile flooring was in place, there would have been little difference in cost between the two methods.

The erection had reached the point shown at the left in Fig. 4 when the builders were confronted with the problem of making provision for two additional floors, to be inserted between the sixth and seventh floors. By changes in the design of some of the upper floors and roof it was possible to reduce the extra weight that would come on the lower columns to that of one extra story. This was important, for as practically all columns run two floors without change of section, there was already present at alternate floors an excess of carrying capacity equal to the weight of one story. With the additional weight reduced, it was possible in many cases merely to reinforce the columns on alternate floors. In general, the columns were strengthened by the addition of cover plates, which were extended through the beam connections. Where these cover plates required, the beams were shortened by oxyacetylene flame, and new end-connection angles were riveted on.

Naturally, one of the biggest problems in the economical handling of the work was the drilling of new holes for the stitch rivets connecting the covers to the column flanges. There were 81,000 of these to be drilled, and by the method adopted an average of 200 holes per drill was maintained in a working day of 8 hours. The work was done by the following scheme, except in the case of the fourth- to sixth-floor columns on the outside of the building, which were taken down and reinforced on the ground.

Two 12 x 12-in. posts, Fig. 6, were set up opposite the two faces of the column that was to be drilled. Cross-pieces were fastened to these posts to support the scaffold planks, allowing quick changes in the elevation of the working platform. Electric drills, counterbalanced to facilitate handling, reacted against the vertical posts.

Complications by Trusses and Street Grades

Where cover plates were already present on columns, secured by two rows of rivets 10 in. on centers, an 8-in. cover plate was added; for this, two new rows or holes were drilled between the old ones. This was because the columns were already under partial dead-load stress, and to remove the rivets in the old covers in order to attach new ones by the same holes was thought to involve the probability of covers buckling, besides exchanging shop-driven rivets for field rivets. Trouble was also anticipated in knocking out rivets, where these passed through more than two thicknesses of metal.

Certain columns, over the court in the upper floors, transfer their load to plate girders. As it was desired to avoid the necessity of reinforcing these girders, the weight of the new floors was kept off the columns that bore on them, by a system of trusses between the new ninth and

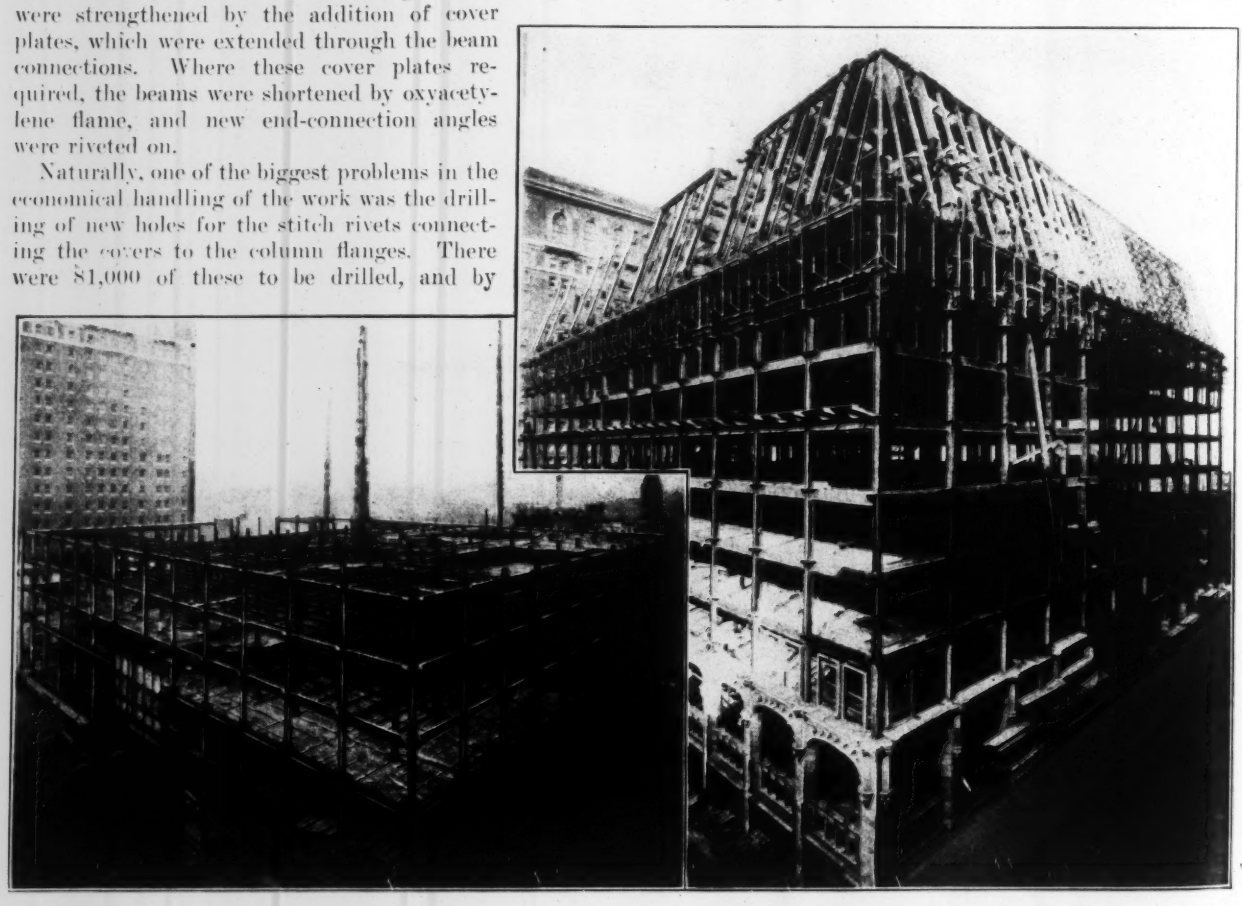


FIG. 1. UNION ARCADE FRAME WHEN ERECTION WAS STOPPED AND WHEN COMPLETED

tenth floors. These are shown in Fig. 2 by plan and elevation. As they are located in a story devoted to offices, it was necessary to provide openings for entranceways

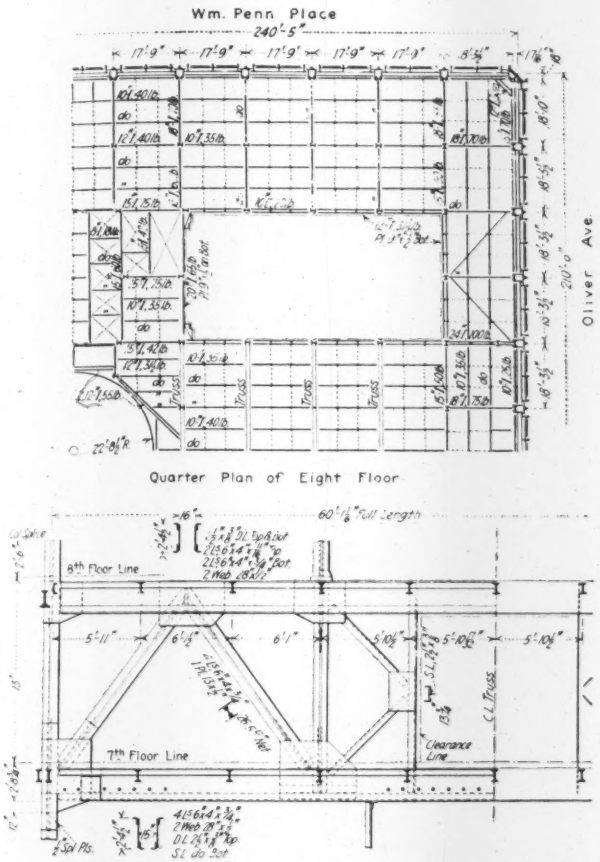


FIG. 2. UNUSUAL TRUSSES IN NINTH STORY TO RELIEVE PLATE GIRDERS OVER COURT OF ADDED COLUMN LOADS

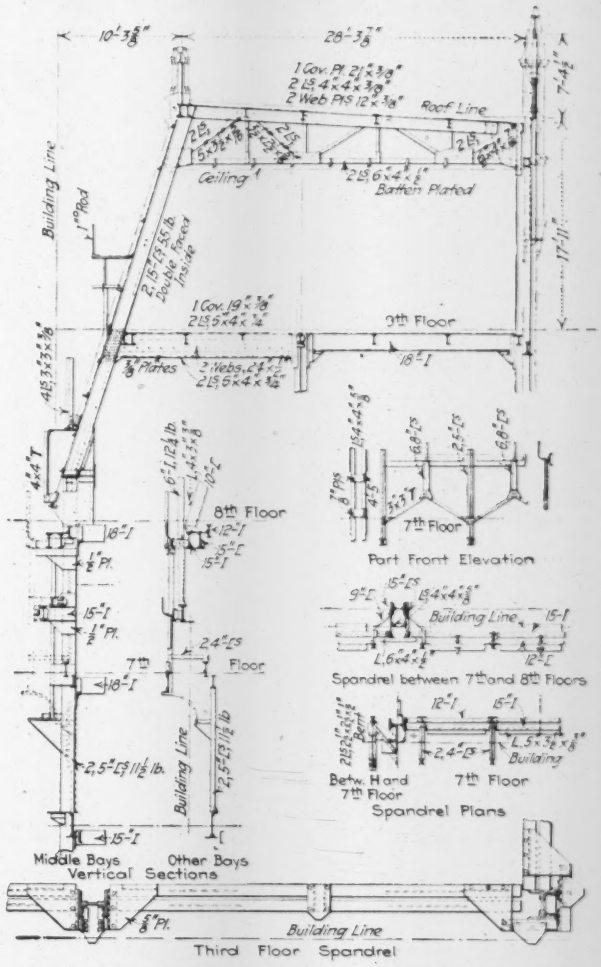


FIG. 3. TWO-STORY MANSARD REQUIRED INCLINED COLUMNS AND SPECIAL BEAM CONNECTIONS

through them. The chords, at these points, were made heavy enough to take shear, and the truss diagonals were omitted.

The building occupies the entire block bounded by Fifth Ave., Oliver Ave., Grant St. and William Penn Place, formerly the site of St. Paul's Cathedral. This block was included in some of the heaviest work of the Pittsburgh "Hump Cut" (see *Engineering News*, Mar. 31, 1913, p. 491), the grade of Fifth Ave. having been reduced from 7.6% to 4.8% at this point, a cut of 14 ft. being made at the Fifth Ave. and Grant St. corner. In improving the property after the cut, an arcade office building of nine stories was planned, with a central court, approximately circular, and arcades lined with shops on four floors. The court is not truly circular, because the block is not exactly square and the two axes of the building intersect at an angle of 90° 57′ rather than at right angles. A four-centered compound curve was fitted

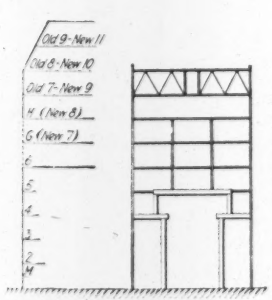


FIG. 4

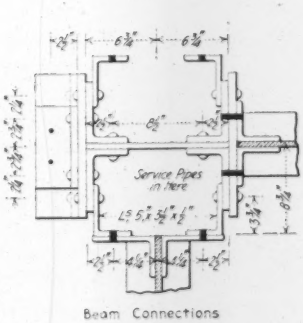


FIG. 5

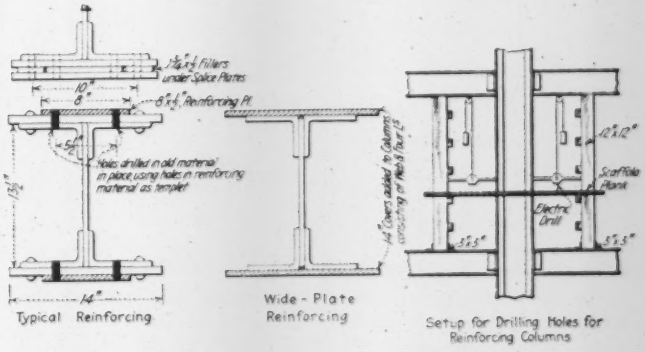

Holes drilled in old material in place using holes in reinforcing material as templet
Typical Reinforcing
Wide-Plate Reinforcing
Scaffold Plank
Electric Drill
Setup for Drilling Holes for Reinforcing Columns

FIG. 6

Fig. 4—Where erection of Union Arcade was interrupted by decision to add two stories. Fig. 5—Sketch of column reinforcing. Fig. 6—Arrangement for drilling stitch-rivet holes in columns to attach new cover plates

to the ends of the two oblique diameters. This obliquity of the axes and the fact that all four streets have different grades, resulting in different elevations for the four arcade entrances, made complications in the detailing of much of the steelwork.

Architectural Considerations

The architectural treatment of the upper part of the building, with mansard roof extending two floors, necessitated some unusual details, both for carrying the principal stresses and for making connections to the elaborate terra cotta finish. The weight of the sloping portion of the roof is carried by the inclined columns, Fig. 3, which act both as columns and as beams.

It was desired to avoid the usual unsightly collection of utilitarian structures on the roof, and so they were all combined in two penthouse towers, with steeply pitched roofs, made a part of the decorative scheme of the building. In this way, space is provided for a few offices in addition to elevator headhouses, tanks and stacks. The stacks are required to follow a tortuous course to bring them out of the towers at the proper point.

F. J. Osterling, of Pittsburgh, was the architect, and L. F. W. Hildner the structural engineer for the building. George A. Fuller Co. had the general contract, and the American Bridge Co. fabricated the steelwork.

What a City Planning a Garbage Piggery Should Know

Indoor Feeding, Daily Clean-Ups, Vaccination, Rat and Fly Suppression Are Essentials to a Successful Farm

FOLLOWING a recent proposal to collect the garbage of Rockford, Ill., and dispose of it on a hog farm at no cost to the city, Dr. W. E. Park, health commissioner, obtained a report on the question by Samuel A. Greeley, a consulting engineer of Chicago. The report is based on the assumption that the city should not expect to secure first-class construction and operation at a cost too low to pay for these advantages. The contractor, on the other hand, should meet the requirements of the city in a free and liberal spirit. Although the party making the proposition to Rockford did not see fit to consummate the deal, the report contains data which are pertinent to other cities confronted with the same problems.

The data consist of a study of the population, area, topography, density of population, present conditions, quantities of garbage, house treatment, location of cans, collection, sanitary aspects of garbage collection, type and number of wagons, service factors, cost of collection, transfer of garbage and disposal.

This Method Is Standard

Some of the points given in the report on this method of disposal are as follows:

It may be said at the outset that the method of disposal by feeding to hogs is a standard method, and is a satisfactory method when properly operated as regards sanitary requirements. On the whole, it is one of the cheapest methods of garbage disposal available, particularly in cities of the size of Rockford. In Massachusetts, in 1909, sixty-one cities and towns were disposing of their garbage in this way. It was stated by the [illegible] the Bureau of Animal Industry in Massachusetts in [illegible] that 95% of the pork produced in the state was [illegible] garbage-fed hogs. There are few of the larger cities [illegible] the country in which some of the garbage from hotels [illegible] restaurants is not separately collected for feeding to hogs.

There are certain general and obvious sanitary requirements relative to the operation of a hog farm for garbage disposal at Rockford. These are the house-treatment and collection phases of the work. If the garbage becomes rotten through infrequent collection, dirty cans and wagons, or is otherwise mixed with foreign substances, its value as a food for hogs is considerably reduced. Therefore the house treatment and collection must be properly adjusted to secure the most satisfactory operation.

Better To Feed Indoors

One of the most important operations at the hog farm is the feeding of the garbage to the hogs. Briefly, three methods of feeding are used: (1) In the open, on the ground; (2) also in the open, but on concrete platforms, and (3) on concrete platforms in buildings. At Worcester it has been found advisable to feed entirely on concrete platforms in buildings. In the old farm at Grand Rapids, some of the garbage was fed under roof and some of it in the open, all, however, on concrete platforms. This was not sufficient, however, to suppress all nuisance, and the farm was relocated at a less critical point. At Denver, garbage is fed on concrete platforms, both indoors and out.

The experience at Worcester is worth describing more in detail. As recently as 1913 the garbage was fed to hogs at the farm by spreading it on the ground. The hogs trampled a considerable part of the garbage into the ground, where it was lost as food and made a decided nuisance. To remedy this condition large wooden platforms, movable from place to place on the farm, were built, onto which the garbage was delivered from the wagons. It was found that the pigs spilled sufficient garbage from the platforms so that at times some nuisance continued. This method was finally abandoned in the fall of 1915, and the garbage has since been fed to the pigs in buildings having a concrete runway down the middle with feeding pens on either side.

If the farm at Rockford should be located at all critically, it would be advisable to require that the garbage be fed to the pigs in buildings. If the location is not too critical, it would be advisable to erect one or two pig houses for feeding garbage to brood sows and young pigs. The remainder of the garbage could be fed on platforms out of doors. Provision should be made in the ordinance for increasing the number of buildings as the changing character of the neighborhood may require. Experience at Worcester indicates that odors from garbage fed in buildings do not usually extend over about 150 ft. from the buildings. Feeding on platforms out of doors distributes the odors a longer distance. Provision should be made in the ordinance that no garbage shall be fed to pigs in buildings placed closer than 300 ft. from a traveled roadway and that garbage fed out of doors on platforms should be at least 600 ft. away.

Provisions should be made for a daily cleaning of the pig pens and feeding troughs. The material so collected

is called pig manure, but comprises, in addition to the manure, bedding and bits of unconsumed garbage. This material decomposes rapidly, with the production of a sour, acrid odor. Its proper disposal is a matter of considerable importance in the sanitary operation of a pig farm. If the ground is sandy and dry and there is sufficient area available, the most satisfactory method is by shallow burial. This must be done promptly. If the pig manure is spread on the ground and plowed into the soil, the burial is not always thorough and some odors result, as was the case at times at Worcester during the summer of 1914. It is also feasible to dispose of the pig manure by composting it in specially built pits. It is found that equal portions of loamy earth and pig manure are required to produce an inoffensive compost. During the colder season it is likely to require more than six months to complete the compost. However, a good fertilizer results, which may possibly be disposed of at a moderate charge.

Hogs Must Be Vaccinated

Undoubtedly anyone operating a hog farm for garbage disposal would, for his own protection, vaccinate the hogs against hog cholera. This should be done, as loss of pigs by death interrupts the garbage-disposal system as a whole and also makes it necessary to provide promptly means for disposing of the hogs by burial. The most danger in vaccination comes from the purchase of cheap serum. It is essential that thoroughly tested serum be used, otherwise the hogs are liable to contract the disease during the treatment.

In the disposal of garbage by feeding to hogs, there is always a possibility of some contagious disease killing off most or all of the hogs. The foot and mouth disease has done this at Worcester, Mass., and at Providence, R. I. To protect against this interruption in the garbage-disposal service the ordinance should require the contractor to provide some temporary means of garbage disposal while the farm is being restocked. Presumably this can be done by burial. Obviously this will be more costly to the contractor than disposal by feeding to hogs, but he should insure himself and the city against this contingency.

Suppress Rats and Flies

At hog farms there is always a struggle to suppress rats and flies. This can be done, provided proper effort is made, and the contractor should be required to construct buildings as nearly rat-proof as possible. These should have concrete foundations with walls extending 2½ or 3 ft. above the ground and a minimum of hollow walls and other shelter for rats. In addition, rat traps, rat poisons, terriers and cats should be employed as required.

The garbage delivered to the hog farm in the summer time will undoubtedly contain a large number of fly eggs and maggots. If the necessary time intervals are allowed, and under satisfactory conditions, these will develop into flies. Consequently, the farm must be maintained in as clean and dry a condition as possible, and garbage of all kinds must be disposed of promptly. In addition, the free use of fly traps, fly germicides, etc., should be required during the summer months. A number of germicides for fly eggs and maggots are used with success, among them being the following: Chloride of lime, kerosene, iron sulphate, carbon bisulphate and sodium arsenate. A sufficient supply of one or the other of these should be kept at the hog farm.

An essential at the hog farm is an ample supply of pure water. The hogs need plenty of water for drinking. This water should be distributed about the farm at sufficient pressure to afford ample facility for washing out the various parts of the plant with a hose.

Sewers should be designed simply and with frequent manholes, so that rats can be driven out. The sewage should be collected at a proper point for disposal in such a way as not to endanger the water-supply nor to make offensive conditions at the farm or downstream.

Some refuse will undoubtedly be collected which is not fit hog food, such as fish scrap and spoiled market garbage. The contractor should be required to give this kind of refuse proper disposal by burial or otherwise. Lack of proper attention to this point may largely counteract the good effects of a sanitary operation of other parts of the work at the farm.

One Cause of "Red Water" Plague

A lucid explanation of much of the "red-water plague" experienced in some water-works systems, together with sound argument for installing high-grade instead of low-grade galvanized pipe was given not long ago by Charles A. Finley, Managing Engineer of the Bureau of Water, Pittsburgh, Penn., in a report to the local Board of Trade Committee on City Water. Mr. Finley said in part:

"The water-supply is the most convenient thing on which to blame plumbing failures and is the hardest to defend by reason of the fact that all water affects all pipes, more or less. The Bureau of Water does not feel called upon and is not in position to either condemn or recommend this or that commercial product used in private-house plumbing; it is, however, fully aware of the fact that there are different grades of galvanized pipe, it is aware of the fact that certain grades rapidly deteriorate, producing rusty water regardless of the nature of the water itself, and that other grades appear to give satisfactory results.

"It is felt that an investigation conducted by an unprejudiced body will reveal the fact that practically all of the complaints due to rusty water are due to the use of an inferior grade of galvanized pipe, or to the age of the pipe; the preceding applies with equal force to hot-water boilers.

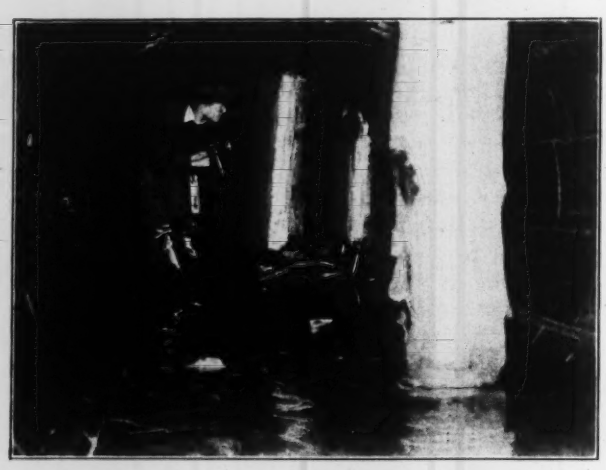
"It is neither feasible, reasonable nor economical to attempt the multiplicity of more or less objectionable treatments which a public water-supply might require, in order to prevent destruction of piping, possibly of inferior quality or coating and not adapted to the demands made upon it. To attempt to do so would lead to endless complications in treatment. It is feasible, reasonable and economical to manufacture and install a grade of piping which will meet all the requirements necessary for the proper transportation of the public water-supply of Pittsburgh; such pipe is now in service and has been for years in satisfactory service and may be obtained in the market at the present time. The fact that there is more or less inferior pipe in service which does not meet requirements is to be deplored, but should not be charged to the character of the water nor should the preservation of this piping be accomplished by means of costly, highly complicated and objectionable treatments at public expense.

THE ENGINEER IN FIELD AND OFFICE

A Department Devoted to Details of the Day's Work

Where Intuition Failed

INTUITION proved a poor substitute for the transit on a piece of work done recently in a city not far from the Ohio River. A railroad was eliminating a grade crossing and had asked the city engineer to locate the sewers and water mains so that piles to support the tracks temporarily could be driven without injury to the under-



AN ARGUMENT AGAINST SURVEYING BY EYE ALONE

ground structures. The city engineer, without the aid of a transit, indicated the proposed center line of a sewer and told the engineer for the railroad that he could drive his piles 3 ft. either side of the line without damaging the sewer. To be safe, the railroad engineer moved 4 ft. over—and the condition shown in the accompanying photograph is the result. An interesting point is that neither the man driving the piles, we are informed, nor the city knew the sewer had been penetrated until a separate investigation had been made.

Deep Wells Cost 0.82 Cent per 1000 Gallons To Operate

COSTS of maintaining and operating for 16 months five deep wells supplying the University of Illinois were equivalent to an average of $151 per year, or 0.82c. per 1000 gal. The following data were given at the recent meeting of the Illinois section of the American Water-Works Association:

Well	First Cost Well Casing and Screen	First Cost Motor and Pump	Operating Cost Labor	Operating Cost Material	Capacity of Pump Gal per Min.	Percentage of Day Pump Was in Operation
A	$559	$375	$172 07	$100 26	60	44
B	546	813	56 51	2 26	69	34
C	699	788	202 73	82 86	81	70
D	1,348	758	113 05	42 93	71	86
E	891	810	147 26	88 08	75	89

The wells have been drilled about 140 ft. deep into glacial drift, and the water stands about 110 ft. below the surface when pumping is in progress. The pumps had been in use for periods ranging from one to eleven years; hence the results are believed to represent fairly well the average performance of the pumps during their useful life.

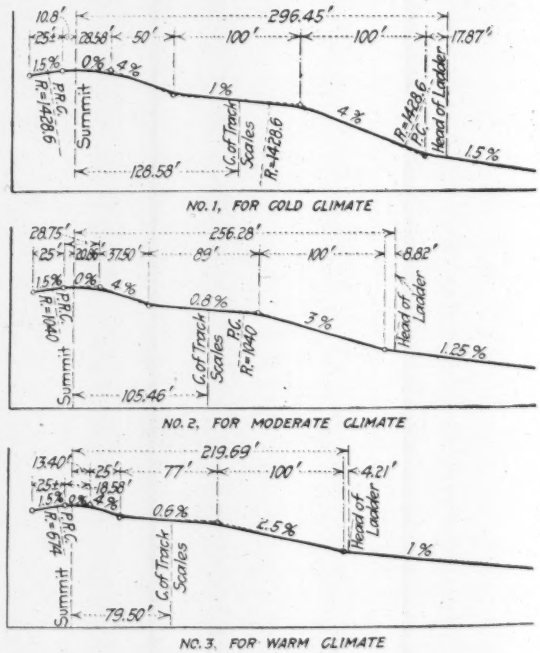
The chief cause of trouble is the fine sand getting into the well and into the pump. Rods, couplings, working barrel and packing are worn quite rapidly. The conditions under which the pumps work are thought decidedly poor.

Climate Should Govern Hump Profiles for Gravity Yards

THREE hump profiles for gravity railroad yards, designed respectively for cold, moderate and warm climates, were adopted on the recommendation of the Committee on Yards and Terminals at the recent convention of the American Railway Engineering Association and will be substituted for the profile now in the "Manual." As the drawings indicate, 4% grades, reduced to 1% over the track scales, are recommended for cold climates while for more favorable climates the grades should be lightened or shortened, or both.

The committee points out that the problem cannot be solved precisely, since the speed developed by cars depends not only on the type of car, but, with the same type, on the length, whether loaded or empty, the lubrication, efficiency of maintenance, temperature, time standing before being pushed over the hump, head winds, care with which the tracks are brought to and maintained at the profile grade and, lastly, the timidity or assurance of the car rider.

In the estimation of the committee there are these seven salient features in the design of a hump:



COLDER CLIMATES REQUIRE STEEPER GRADES

1. A short grade steeper than the approach grade to bunch cars.

2. A level grade over the summit, these grades to be of such length as to form the tangent to a reverse curve connecting the approach grade with the first descending grade.

3. A short grade from the summit, to separate the cars quickly and give them the desired speed for weighing.

4. A light grade over the track scale.

5. A moderately steep grade, the rate and length depending on the traffic, to the end of the ladders.

6. A grade through the ladders sufficient to maintain the speed throughout the turnout.

7. A light grade that will just overcome in the length of the body tracks the speed already acquired.

Profile Paper Advantageous for Taking Topography for Railroad Location

By. F. T. HOWES
Resident Engineer, Northern Pacific Railway, Manhattan, Mont.

PROFILE paper has been used profitably by the writer in taking topography for railroad location. With the small graduations normal to the base line cross-section distances can be laid off very readily, while the advantage of separate sheets is obtained by cutting the paper as desired.

The general field practice is to sketch the contours in either notebook or on sheets of mapping paper. Sketching in books has the disadvantage of requiring considerable labor in transferring the contours to the map, hence to save time the method of drawing contours on sheets is sometimes used. In this method the base line is platted on the mapping paper to scale previous to use in the field; the contours are located on the ground, laid off to scale on the sheets, and afterward transferred to the map by placing carbon paper under the sheet of topography, orienting the latter and tracing with stylus.

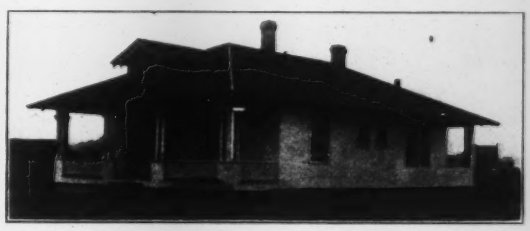
As a modification of the latter method the writer has cut ordinary plate A profile paper (hard copy) into 6 x 12-in. sheets, the 12-in. edge being parallel to the long edge of the roll. On the border of the sheet are written the station and elevation at the usual ¼-in. intervals. One of the heavy lines in about the center of the sheet and parallel to the longer edge is then taken as the center line of survey. The other ruled lines of the sheet will facilitate platting of the contours without the aid of a scale, since the paper is divided by these lines into a scale space representing 100 ft. along the center line and 20 ft. at right angles thereto. This gives a scale of 400 ft. to the inch.

Wherever angles have been turned, a space must be left to prevent an overlapping of contours. The angles should be laid off with a protractor to indicate how far the topography should be extended.

This method is best adapted to a mapping system drawn to a scale of 400 ft. to the inch, although other scales may be used. Sheets 6 in. wide will cover a strip equivalent to 1000 ft. on each side of the center line, and if a greater width is desired, a separate sheet for each side of the center line may be used.

Build Permanent Camp for Future Power-House Construction Forces

A PERMANENT construction camp, to house the forces that will do expected future work at its main power plant as well as that to be done at once, involving more than $1,000,000, is being built by the Empire District Electric Co., of Joplin, Mo., at Riverton. Around a two-story hotel accommodating 80 men, built in 1910, the company has erected a 120 x 25-ft. bunkhouse for 130 men, a mess hall for 150, a house for the construction superintendent and his 15 assistants, another house for the operating engineer, and is finishing six six-room bungalows for the engineers on duty at the power house. The buildings have steam heat and electricity from the power house, also refrigerators, hot and cold water and shower baths. Both mess hall and hotel are equipped with cold-storage rooms for supplies and a garbage-disposal system. The company thus accommodates about 250 men with board and lodgings for $6 per week.



MESS HALL AND BUNGALOW—HOTEL AND BUNKHOUSE ARE SIMILAR IN APPEARANCE

Breaking of Wooden Flagpole Shows Danger of Decay

By A. S. LOTSPEICH
Inspector of Buildings, Portland, Ore.

NOT long ago one of the flagpoles on a high building in Portland broke off at the roof line and fell backward upon the roof. If it had fallen to the street, 150 ft. below, many people might have been killed or injured. An examination of the broken end of the flagpole showed that it was badly decayed at the roof line, where it was surrounded by copper flashing. Yet it looked sound on the outside, and only very careful inspection would have shown the danger. It had been in place only seven years.

There are many other flagpoles that are supported by extending them through the roof to the framing several feet below and that are without braces or stays above the roof. Some are 40 or 50 ft. high. Rainwater can usually run down the pole inside the flashing, and then decay is almost certain to start in a few years.

The proper way to support a flagpole is by running a strong piece of steel beam or channel iron from the ceil-

ing to a point 3 or 4 ft. above the roof, fastening the pole to this with iron straps and, if the pole is tall, guying or bracing it to the roof so that it cannot fall to the street even if it should break. The pole should not extend through the roof.

Owners of buildings on which there are large flagpoles should have such poles examined frequently, and repaired if there is any weakness or decay. All elevated objects such as signs, billboards, cornice ornaments, chimneys and poles, which might fall to the street and injure persons who are passing, should be watched by the owners or those responsible; and if there is doubt of their safety, the Bureau of Buildings should be notified. A large number of street signs in Portland have been inspected lately by the inspector of buildings.

One Year's Tests of Field-Made Concrete Give Comparative Figures

COMPRESSION tests of 8 x 16-in. cylinders cast from concrete taken from forms have been made on practically all the work under the jurisdiction of the New York Public Service Commission, in connection with the construction of the new rapid-transit lines in New York City. The results of one year's series of such tests have been collected in the accompanying table, to which have been added for purposes of comparison the compression values prescribed by the final report of the Joint Committee.

RESULTS OF ONE YEAR'S TESTS ON FIELD-MADE 1:2:4 CONCRETE BY NEW YORK PUBLIC SERVICE COMMISSION*

	28 Days, Average Lb. per Sq In.	No. of Tests Represented in Average	90 Days, Average Lb. per Sq In.	No. of Tests Represented in Average	Increased Over Corresponding 28-Day Tests
Average of all tests	1,725	84	2,100	59	21%
Coarse Aggregates:					
Mixed Long Island beach sand and gravel	2,155	11	2,370	8	24%
Long Island beach gravel	1,880	10	2,185	3	18%
Hudson River limestone	1,880	10	2,240	10	14%
Hudson River dolomite	1,790	4	2,280	3	23%
Hudson River traprock	1,630	16	2,035	10	17 5%
Long Island bank gravel (washed)	1,550	31	1,990	24	25%
Fine Aggregates:					
Sand excated on the work	1,775	9	2,285	7	25%
Long Island beach sand	1,690	24	2,020	13	15 5%
Long Island bank sand (washed)	1,610	38	2,050	30	21%
Hudson River bank sand	1,135	1	1,837	1	62%
Consistency:					
Medium	2,220	18	2,425	14	10%
Wet (stiff enough to keep coarse aggregate from settling to bottom)	1,710	47	2,070	39	24 5%
Very wet (coarse aggregate settles to bottom)	1,580	13	2,300	1	33%
Extra wet (soupy)	1,185	7	1,320	6	10%
Mixer:					
Machine	1,750	80	2,100	59	21%
Hand	1,290	4			
Joint Committee:					
Granite and traprock	2,200				
Gravel, hard limestone, hard sandstone	2,000				
Soft limestone and sandstone	1,500				

* All tests of doubtful accuracy have been omitted, and in computing the averages the result of any test that differed more than 50% from the average has been excluded. Each test consists of three specimens. Aggregates were specification material in every case. Dimensions of specimen cylinders, 8 in. in diameter by 16 in. high.

Central Parkway Eliminates Danger on a Bad Highway Curve

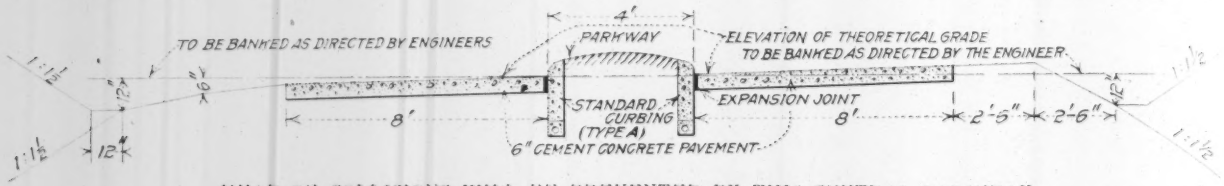
By W. J. HEALEY

Assistant Engineer, New York State Highway Commission, Albany

IN DESIGNING a portion of the state highway between Chestertown and Hague, in Warren County, N. Y., it was necessary to put in a curve of 200-ft. radius on a 7.4% grade, *I* being approximately 80°. Since this section of the road was wholly in cut, ordinary construction would have proved very dangerous. Though several changes of alignment were tried, they were abandoned on account of their excessive cost.

The method finally adopted for meeting this condition has met with general favor. In brief, it consisted in inserting a parkway in the center of the road effectively separating the opposing lines of traffic. To insure that traffic will become aware of the change from the usual construction, this section begins 50 ft. from the P. C. and ends 50 ft. from the P. T. "Keep to the Right" signs are to be placed at the ends. This provision will be of particular value at night, since it is improbable that headlights will fail to illuminate the signs.

Though the same width is maintained as on the standard section of the road, the excavation is increased by the amount necessitated by the insertion of the 4-ft. wide parkway. In this particular instance the extra excavation amounts to 200 cu.yd. and will probably cost about 50c. per cu.yd. Furthermore, 800 lin.ft. of concrete curbing, at 50c. per lin.ft., will be required, making the total cost of this safety feature about $500. When it is considered that a minor automobile accident would probably result in damages considerably greater than this figure, the value of this particular treatment seems rather obvious, and it is probable that the scheme will be come standard on New York state-highway construction.



HEAD-ON COLLISIONS WILL BE PREVENTED BY THIS CENTRAL PARKWAY

Independent Base Eliminates Vibration of Meter

AN INDEPENDENT concrete foundation to carry a venturi-meter clock solved the problem of excessive vibration, writes J. H. Honey, of Fajardo, P. R., in a recent issue of *Power*. In setting up the meter he had found that owing to the vibration caused by the heavy mill machinery the meter clocks would not run and the pen arm vibrated so much that accurate records could not be obtained. A concrete foundation for the meter was put down with 2-in. clearance all around between it and the factory floor. A 2-in. bed of sharp sand was put on the concrete base, a wooden block was bolted on top of that by ½ x 10-in. bolts, and the meter was fastened to the block. With the meter on this foundation no vibration has been noticeable and the records have been perfectly clear and legible.

EDITORIALS

Speed Up Production

IT IS reported that in some parts of the country the entry of the United States into the war is regarded as a signal that a period of business depression is at hand. Howard Coffin, of the Council of National Defense, in an interview published on Apr. 20, said that in returning from a business trip in the Middle West he found there a hysterical fear of a change in business conditions. In some quarters production was being cut down and workmen thrown out of employment. "We need prosperity in wartime," said Mr. Coffin, "even more than when we are at peace. The declaration of war can have no real evil effect on business. What bad effects are apparent are purely psychological and largely of our own foolish making."

On every hand is convincing evidence that, so far from being at the beginning of a period of business depression, the coming season is to witness the greatest activity in production ever recorded. The best index of business depression is unemployment, and there never was a time in the memory of men now living when the demand for labor was so urgent as at present and when labor received such high wages. There is work for every one, skilled or unskilled, more work by far than there are workers. It is not alone the enormous demands for workers to supply the needs of a million men and more who will be withdrawn from production to serve in the army and navy—to make for them clothing, arms, munitions and fighting machinery of every sort from aëroplanes to battleships. There is besides this the insistent demand, which everyone is now heeding, for the mobilization of labor to speed up agriculture, and the scarcely less urgent demand for labor to build ships to carry food to our allies. Added to this is the fact that this nation of over a hundred million people with everyone working at the highest wages ever known has the greatest buying power in its history.

Not only is active production the need of the hour, but it is a present condition. The railways of the United States on Apr. 1 reported the largest car shortage ever recorded, a total of 143,059 cars. In normal years the spring is the season for car surplus and not car shortage. The problem of American business men this year is how to make the largest possible production in order to supply a world demand.

A Rush Job of City Building

TO BUILD 48 cities, each capable of housing a population of some 12,000 people, and have them completed early in August, ready for occupancy, is about the size of the task that the War Department will probably soon ask the construction forces of the United States to accomplish. While the plans are not yet made public in final form, nor can be until the necessary legislation is passed by Congress, the general scheme of the War Department in connection with the first new army unit of 500,000 men is substantially as follows: The bill pending in Congress, drawn by the general staff, provides that the President shall divide the whole United States into 16 divisional areas of approximately equal population and appoint a general officer to the command of each divisional area. The commander may subdivide the divisional area into three "reserve areas"; these reserve areas are to be subdivided into districts and subdistricts, apparently for the purpose of registration and levying of recruits. It is not yet known how many training camps will be established in each of the 16 divisional areas, whether one or more. There is some reason to believe, however, that a training camp may be located in each "reserve area," which would make 48 training camps for the whole United States; and each camp would therefore have to accommodate something over 10,000 recruits. Making due allowance for the auxiliary forces necessary to supply and maintain this force, it appears that the task ahead of us is to build 48 cities, each capable of accommodating at least 12,000 persons, and to do this within three months.

We say three months' time, because the plans already made public for 14 officers' training camps with 2500 men in each, which are to be assembled on May 8, provide for three months' instruction. Since it is planned to have a force of trained officers ready at the end of three months to begin work with the 500,000 recruits, it is or should be the plan of the army to have the camps for the recruits ready and occupied by that time.

These 48 cities will be made up of wooden buildings. It is impossible to shelter this half-million men in tents, for there are not enough tents available in the army stores to provide for even the 35,000 men to be brought together in the officers' training camps, nor is there material available to make tents in any reasonable time. It is reported that the army has been endeavoring to place an order for 30,000,000 yd. of cotton duck. This order will take the mills a long time to fill, and much of the material will be required for use for tarpaulins and similar coverings as fast as it can be furnished. Of lumber for wooden buildings, there is fortunately an ample supply.

Doubtless, these buildings will be of the simplest possible construction, to admit their rapid erection with as much use as possible of unskilled labor. They will probably be made fairly permanent, as it is the intention to use them not only to house the first half-million recruits, but the second half-million and additional units.

Besides the necessary buildings for the camps, there must be supplied the equally necessary provision for water-supply and sewerage, together with storm-water drainage, sufficient roads, terminal facilities, etc., to handle the supplies required by this great number of people.

The present plan of the Government, according to our best advices, is to let a contract for each of these encampments to a large, responsible contracting firm with a first-class organization and a reputation for rapid work. This will concentrate responsibility and it is hoped will secure efficient and rapid work. The magnitude of the task, however, will probably make it necessary for these main contractors to enlist the aid of as many subcontractors as possible in each locality.

All this activity must wait, of course, upon the action of Congress. Until it passes the bill to create the new army and makes the necessary appropriations to build the camps in which the army is to be trained, nothing but preparatory work can be done.

Holding Men on the Job

EVERY contractor and every engineer in charge of construction work will find it well worth his while to study the experience of the Rock Island R.R. Co. on its Chicago track-elevation work described on page 186 of this issue. It appears from the detailed official figures that, in order to keep filled an average working force of about 400 men, no less than 2874 men were taken on the job in the last six months of 1916. More than half the men who were hired left the job after working from a day and a half to eight days.

It is of course well known that this plan of employing labor, hiring and firing every day as necessities arise, has been long prevalent on construction work. It has been assumed that, in ordinary civil-engineering construction, skill and experience in the common laborer are so unimportant that a man can be taken on the job, put to work immediately, fired or permitted to quit in a few days and another man put in his place—all this without any material effect upon the cost of the work. The falsity of such assumptions has been shown time and again ever since the days when the late Fred Taylor, in his efficiency studies at the Bethlehem Steel Works, found that a great reduction in the cost of labor could be made, even on such rough work as shoveling ore into barrows or piling pig iron, merely by studying the motions of the individual workman and teaching him how to do his work efficiently.

Many contractors and engineers are aware today that by thoroughly training all the men of a gang engaged on certain work, such, for example, as laying a pavement foundation, the amount of work turned out in a day can be greatly increased. If, however, it is impossible to keep men steadily on the job, the only training that can be given is the mere "slave driving" of the boss, and this sort of training is of course one cause why the workers quit. It must be frankly admitted, too, that the floating hobo worker, who has for years been accustomed to frequent shifts from one job to another, does not take kindly to training anyway, especially in times like these when he knows perfectly well that, if he quits, another job is waiting for him around the corner.

Nothing is more certain than that the United States is face to face with conditions in which efficiency of labor is of the highest importance, not merely for the profit of the individual enterprise, but for the national defense. During the next six months the United States needs much more labor than it has available. It must be lavish with labor in all agricultural work in order to produce the greatest possible amount of food. It must build ships and produce iron and steel at a rate without precedent. It must withdraw from productive work at least a million men for the army and navy, and it must employ an enormous number of other workers to supply the needs of these fighting forces. It will be impossible to accomplish all that every patriotic citizen hopes to see accomplished unless a high standard of efficiency can be maintained all along the line.

During the past three or four years, the problem of increasing the efficiency of the ordinary laborers on engineering construction has been given attention that it has never before received. A number of large contractors have been giving careful study to such matters as the housing and feeding of field forces, as well as to their more careful selection and training. Experience has developed that this study and expenditure are not only justifiable on humanitarian grounds, but that it pays in dollars and cents.

There is, for example, a certain piece of public work near New York City being carried on by force account and involving ordinary handwork in rock and earth excavation, on which there have been very few changes in the working force since the work began, over a year ago. Men have stayed on the job week after week and month after month; in fact, many of them have been steadily at work for this same organization for over two years, yet the wages paid have been on the whole considerably below the scale prevalent in the vicinity. Labor agents from munition plants have endeavored to get the workmen away by the promise of higher wages, but without result. The reasons for this success involve nothing elaborate or difficult. At the outset of the work substantial and comfortable frame buildings were erected to house the men—a necessary feature, as the work was remote from any town. Pains were then taken to see that the men had an ample supply of good food, cooked and served in the way the different nationalities desired it. These have been the two main influences that have kept the force intact, and the amount of work accomplished has been satisfactory proof of the laborers' efficiency.

The Hog Volunteers To Utilize Municipal Food Wastes

WHEN food is in such present and prospective demand as it now is, waste should be kept down to the irreducible minimum and unpreventable food waste utilized to the maximum. Do their very best in food saving, urban populations pass immense volumes of waste food materials to the garbage can every day. Where the best is not done, the waste is still more serious. A goodly number of the larger and some of the smaller cities of the United States send their garbage to reduction plants where grease and fertilizer base are recovered. The grease now sells readily at a high war price, and besides producing revenue and conserving other resources its production reacts favorably on food supplies. The fertilizer base is an obvious contribution toward keeping up the fertility of the land in a time when fertilizer is scarce and costly and fertility needed more than ever before.

Undoubtedly, garbage-reduction plants are doing much and might do far more to utilize food wastes, but it takes much time and money to build them, technical skill to operate them, and commercial ability to market their products. All these are serious matters for private enterprise and, as things municipal generally go in the United States, still more serious as city undertakings. Moreover, only cities of considerable size have as yet appeared to offer favorable opportunities for garbage reduction. Immediate, simple, inexpensive and at the same time profitable means of utilizing garbage now going to waste are needed, especially by a host of smaller cities, towns and villages.

The hog volunteers to utilize municipal food wastes in the quickest, simplest, cheapest and most profitable manner, or if preferred he will submit to selective draft or

indiscriminate conscription. A ready market offers $16 per hundredweight for the end product.

The hog is not a very sentimental animal, but there has been no end of sentiment against utilizing him for garbage disposal. Quite aside from war emergencies, it is high time that this kind of sentiment gave way to commonsense and scientific knowledge.

If a modicum of the scientific knowledge required to design, build and operate a garbage-reduction plant were devoted to a municipal piggery, the sanitary results would be at least equally good, while it is possible that the profits per ton of garbage would be considerably higher.

For years past, the garbage of many American cities has been successfully fed to hogs. The practice would have been adopted in many other cities and continued where abandoned, had it not been for zealous but ignorant opposition on the ground that the practice is insanitary. Had these opponents looked beyond the end of their noses, they would have seen that and where garbage feeding to pigs had been insanitary it was through utter lack of observing the most elementary laws of sanitation.

The sanitary essentials of garbage piggeries, as well as some notes on experiences with feeding garbage to pigs, are given elsewhere in this issue in the form of an abstract of a report made by a well-known sanitary engineer and garbage-disposal specialist for the guidance of Rockford, Ill. The article deserves the careful attention of sanitary engineers, city officials and food conservationists.

Prophecy Come True

MOST engineers, particularly those engaged in municipal work, appreciate fully the value of the bulletins issued by the National Board of Fire Underwriters on the fire hazards in American cities. One by one all the cities of the country are being subjected to the close scrutiny of its experienced corps of fire-protection engineers, who spend weeks and months in each place, studying and reporting on not only the broad question of fire hazards, but such contributory matters as building regulations, city planning, water-works equipment and even such political conditions as might react upon the morale of the city's fire-fighting force or equipment.

Unfortunately, appreciation of the value of these reports is confined largely to those intimately connected with the subjects which they treat—that is, the fire insurance interests and a few engineers in municipal service. The citizens, and in many cases the city officials, too often do not heed the warning.

A remarkable example of this has recently occurred in Pittsburgh. In 1915 the National Board of Fire Underwriters published a bulletin of Pittsburgh fire hazards, which included a map of the congested district. Centered on that map was a blackened area, denoted with special emphasis in the report as the one block where extraordinarily bad conditions prevailed. This central position was declared to be a possible focus for a spreading conflagration that might repeat the San Francisco or the Baltimore disaster. In addition, recommendations were made, both as to the protection of this district and as to the personnel and control of the fire department, which in the opinion of the experts would materially better fire-protection conditions both at this center and in the city in general.

The report received the customary official inattention for two years, until on Jan. 27, 1917, when it was called to mind by a fire that broke out in the very block indicated as dangerous in the report of two years before—a strictly preventable fire, had the earlier warning been heeded.

By great good fortune this fire was not accompanied by loss of life. It started at night when the downtown district was deserted and at a calm period when there were neither disturbing winds nor other fires to promote the spread of a conflagration. In spite of this, practically the entire block was destroyed, with a loss of several million dollars.

It is rare that definite technical prophecies have so prompt a fulfillment. *Engineering News-Record* is glad to do what it can to increase the publicity that the National Fire Protection Association is giving to this incident.

Corporations May Be Architects

THERE has been a very strong tendency during the past quarter-century to transfer professional work from the hands of individuals to corporations. This has been especially the case in engineering. Even in the legal profession, it has been said that if the statutes permitted corporations to engage in the practice of law, a large proportion of the lawyers would have to close their offices and become employees of some corporation. The Supreme Court of Illinois recently handed down a decision that is of considerable interest in connection with the question whether a corporation may undertake professional work. Under the Illinois law governing the practice of architecture, every architect, in order to practice his profession, must have a license from the State Board of Architectural Examiners. A sentence in Section 5 of the law reads: "No stock company or corporation shall be licensed to practice architecture, but the same may employ licensed architects."

It was doubtless the idea of the architects of the state, in securing the passage of the licensing bill, that this section would maintain architecture as a personal profession and act as a barrier against the growing tendency for professional business to fall into the hands of corporations.

In accordance with this idea, the State Board of Architectural Examiners brought suit against the Rodgers Co., of Chicago, which performed the architectural work in the building of a church at Niles, Ill. The trial court held that the corporation had transgressed the law; but the case was carried to the Supreme Court of the state, which has now ruled that corporations may practice architecture, provided they employ a regularly licensed architect to do the work. The court declared that "making contracts for services to be performed by an architect and collecting the compensation therefor is not practicing architecture within the meaning of the statute." The court further declared that the purpose of the statute was not to protect architects by limiting the work to those architects who possess a license, but to protect the public against incompetent architects. It is evident, therefore, that if the Illinois architects wish legislation to prevent architectural work from gravitating into the hands of corporations, they will have to secure a new act and further will need some good legal advice.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcomed

Minimum-Mean Rainfall at Mechanicsville

Sir—The article in *Engineering News* of Mar. 29, 1917, on "A Safe Method Proposed for Estimating Minimum Rainfall," by James P. Wells, naturally suggested a somewhat similar study of run-off. Probably the longest record of natural stream flow in New York State is of the Hudson River at Mechanicsville, where records have been maintained from October, 1887, to date. The mean yearly run-off for the 29-year period, 1888 to 1916, inclusive, was 23.21 in., and the minimum yearly run-off was 18.38 in., giving a minimum-mean factor of 0.79, which is considerably higher than the 0.6 minimum-mean rainfall factor obtained by Mr. Wells. This would seem to be contrary to the usual hypothesis that the greater the rainfall the greater proportionately the run-off, and would indicate that this theory holds only to a certain point; that is, in dry years the groundwater storage appears to hold up the low-water flow and make the low annual run-offs higher than they otherwise would have been.

We may deduce from the foregoing that if a hydraulic work is being designed on a basis of the minimum rainfall, the same rainfall run-off factor should not be used for minimum and average conditions.

EDWARD H. SARGENT,
Ass't. Engineer, Water Power Storage and Drainage.
New York State Conservation Commission.
Albany, N. Y.

Finding Fink Web Stresses Graphically

Sir—In reading "The Story of *Engineering News*" in the Apr. 5 issue of *Engineering News-Record*—the consolidation of *Engineering News* and *Engineering Record* is an energetic master stroke and deserves the greatest commendation—my attention was focused upon "The first appearance of *Engineering News* as a weekly," for in that particular issue of Jan. 1, 1876, there is an article by Prof. Charles E. Greene on the "Graphical Analysis of Roof Trusses." In discussing the Fink truss, Fig. 10, Professor Greene says: "If then we attempt to analyze the joint *DE*, we find that, with the external load, we have six forces in equilibrium, of which those along *KL*, *LM* and *ME* are unknown. If we try the joint *LA*, we find four forces, three of which are also unknown. We are therefore obliged to seek some other way of determining one of the stresses."

The procedure then followed by Professor Greene is based upon the assumption that the truss is symmetrical and the panel loads are equal. It is interesting to note that this method of analysis has not been improved upon until quite recently; for if we refer to standard works, we find that the authors either substitute an imaginary member in the truss outline or adopt other methods that would fail under certain conditions of roof loading. Consequently, I developed a new and logical solution to be employed regardless of roof-loading conditions.

It seemed strange to me after my investigations had been made that this further advance in the art of determining stresses should have been overlooked by other writers in their investigations. I am taking the liberty of sending you my article.

HARRY B. WRIGLEY,
Mechanical Engineer.
Allentown, Penn.

[The writer's solution, as printed in the *Building* [illegible] of May, 1916, consists of drawing the graphical diagram for the left-hand half of the truss, as though it were an independent truss, and then applying the web-members part of this diagram to the full truss; the addition of the right-hand half does not change the left-hand web stresses, but only increases the chord stresses.—Editor.]

Should Not Engineering Students Learn How To Study?

Sir—Several articles in *Engineering News* during February and March of this year discussed the question, "Should Not Engineering Teachers Know How To Teach?" A related matter that ought to be studied is: "Should Not Engineering Students Be Taught How To Study?"

There are two ways of making a man accomplish a given task. In the first and almost universally applied one, tools, apparatus or books are turned over to the worker, and the order, "Do it," is given. The responsibility for discovering methods of accomplishment rests solely with the employee. If, in shoveling, he is using an ore shovel to handle ashes, he is to do the best he can with the tools available. In late years a second method is growing steadily in its application in the shops of this country. Responsibility for equipment and complete instruction rests with the management. In shoveling, the worker is to be supplied with the right type of shovel.

In most colleges, students are turned loose with a few texts, professors and the demand, "Get a passing grade or leave our institution." Of course, results are visible, but they fall far short of what might be done. It certainly is logical to believe that the application to college work of the same principles that have produced tremendous results in other fields would be equally successful.

The work might well be started by dividing each day of the week into periods of home study, work at school, exercise, relaxation, etc. Then too, how many instructors apply in the classroom the methods that have actually been proved the best under the conditions involved? It is too broad a subject to gage the methods with mathematical accuracy, just as the arbitrary division of the students' time would be; but certainly a great improvement could be made. A combination of lectures, board work, recitations, submitted problems and quizzes could be arranged that would leave no doubt in the minds of students or instructors about the students' grasp of the fundamental principles of the subjects taught and their application.

The majority of students do not know how to study. To spend four years at study and not know the best methods of study is the height of inefficiency, yet that is what is done in practically all our high schools and colleges. Many students may realize that x minutes daily on a subject for four days may result in 90% of the

subject being mastered, while 4x minutes applied at a sitting gives a value of only 55%, yet do not apply this principle to the fullest extent. In one university a course on how to study was open to freshmen and produced marked improvement in school work.

It should be the business of the faculty to see the actual application of the best methods to all student work, from brushing the teeth to the solution of a calculus problem. Students cannot do their best work when tired, in uncomfortable positions, with poor light, when not in good physical condition, etc. Such drawbacks must be removed, to produce the best results.

Students must have proper exercise at the right time to remain in condition and do good work. Military training, gymnasium classes, instruction about bodily care, all are useful in producing and preserving a sound body. Recreation is as necessary as study. Even in grade schools, teachers have found it necessary to instruct children how to play. The theater and various games, mental and physical, fit in here. Scientific management discovered a secret of efficient work in relaxation at proper intervals.

Perhaps the system could be best applied to the second term of the freshman year. In some colleges many features might have to be modified. I should think the best results would be accomplished in schools where every hour of the students' time would be under the observation of capable officials who would see that the best methods were applied in every act, making so far as possible an absolutely efficient disposal of four months of the students' time.

The students would come out of a course of this nature with more knowledge and a real training in the use and conservation of their powers. Such training should result in a well-balanced life in the majority of students that in itself would repay all the efforts made.

Rose Polytechnic Institute, E. H. GOLDSTINE.
Terre Haute, Ind.

Tidal-Water Sewer-Outlet Questions

Sir—In designing sewer outlets on tidal-water fronts where the street elevations are limited it is frequently impracticable to avoid tide-locking the sewers at times of high water. In Manhattan the sewers in large areas are so affected twice a day and in at least one instance for a distance of a mile from the outlet, and a similar condition exists in the other boroughs of New York. The choice is presented of pumping the sewage at a very considerable expense, at least during high stages of the tide, or of permitting the surcharge of sewers, accompanied by a probable reversal of current and an accumulation of deposit to produce foul gases and from time to time require removal.

The actual degree to which such conditions are believed to be detrimental has never, so far as the writer is aware, been expressed. What definite benefit, for instance, may be expected by substituting a decreased velocity for a reversal of flow by employing tide gates? What other devices, such as periodical flushing, have been actually tried out to avoid the installation of pumping or the crude method of hand cleaning? Under what circumstances would a change in street grade be warranted? Apparently no attempt has been made in the past to standardize practice in this respect, and it is here suggested that the experience of the sewer departments of our coast cities in dealing with the question of back-flooding, the control of deposits in sewers along the waterfront and the elevation at which outlets are customarily placed with reference to mean or extreme high-water level would be matters of much professional interest. It is hoped that this letter may bring out a discussion of the subject.

KENNETH ALLEN.
Engineer of Sewage Disposal.
Municipal Building, New York City.

Adjusting the Salaries of Engineers

Sir—The present period, witnessing various movements toward regulating remuneration for services in many trades and professions, is not an inopportune time for the engineering profession to give serious consideration to its own vital needs in this direction. Statistics indicate a rapid and consistent advance in practically every field but that of technical endeavor. Plans of remedial nature have been laid before the profession from time to time, but no collective action has been taken to develop them. For obvious reasons, we may accept as axiomatic that labor's instrument of protection and aggression, unionization, is not and probably never will be acceptable. But a wholly different line of action is open through which the same goal might be attained, and without antagonizing the employers as a class—for the direct and immediate result would be decidedly to the advantage of the employer or employing corporation.

As a concise illustration: Let joint committees from the national technical societies select a "Commission of Engineering Standards" to standardize the various gradations of the engineering profession. The lowest standard grade would be, say, that of rodman, draftsman or equivalent titles. Qualification for certification to this grade would necessitate two years' practical experience in the particular class of engineering work for which certification is desired, and merit, as reported to the commission by former superiors, would be the sole evidence considered in awarding or withholding certification. Certification to the succeeding standard grade would turn on technical and executive ability actually demonstrated and reported. A nominal fee would be paid to the commission for each initial and succeeding certificate of classification, to provide for operating charges.

No exhaustive examinations would impede the functioning of the commission. Since its routine would be the consideration of submitted reports only, its operation costs would be light. Yet its decisions in classification would be indisputable, for no mere examination could hope to compete with the exact analysis made possible by the scrutiny of a record of past performances.

Engineering standards being established, the apparent supply of available material will be diminished, and a marked advance in remuneration, grade for grade, should be assured over the rates prevailing in the pre-standard period. For the employer this should prove a distinct financial gain, for he would be enabled to build up rapidly and accurately an organization of an efficiency possibly 100% greater than that to be expected of the old method of selection, under which it was necessary to take much on faith.

Scranton, Penn. E. B. BURR.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

"I APPRECIATE the opportunity for telling of our devices in this department. It is not alone because it pays us nicely for the time and labor required to get together the information, pictures, or drawings.

"I have happened upon, or devised, many time- and labor-saving contrivances that I enjoyed telling my friends about.

"But I did not think them worthy a place among the articles of a high-class magazine, until this section was opened.

"In fact, I was not expecting pay for the first letter I wrote about my use of the camera in bridge construction, and was surprised when I received a check. Likewise, the check for the description of the change made on a planimeter was unexpected."

THIS is part of a letter which we have received from a contributor to

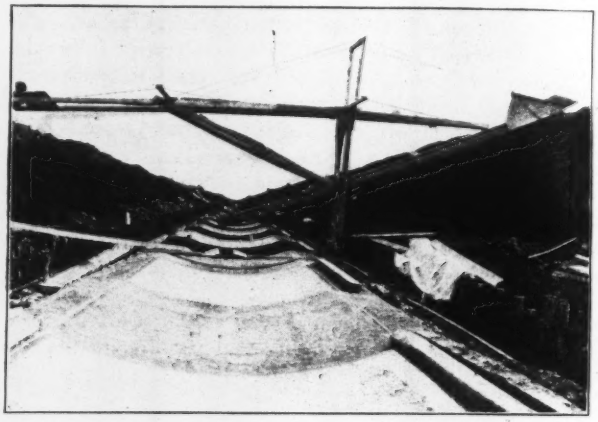
HINTS FOR THE CONTRACTOR

Traveling Chutes Deliver Concrete for Arch and Invert of Winnipeg Aqueduct

By WILLIAM SMAILL
Superintendent, Winnipeg Aqueduct Construction Company, Limited, Winnipeg, Man.

THE first-season concrete on the Winnipeg Aqueduct work, described on page 180 was delivered to the arch and invert forms by means of steel or wooden chutes, with a widened hopper at the top end for cars to dump into. There were generally three of these chutes placed to each arch and one at each invert to be poured. They had to be supported rigidly by means of horses and blocking, to withstand the shock of the dumping of concrete cars. The steel chutes were found to be heavy to move, and wooden ones wore out or were rapidly broken up. Besides, it took a considerable number of men and much time to place and move the chutes.

The writer, last winter, worked up several schemes and finally decided on a traveling chute that would operate on the same track as the form traveler and have no connection with the concrete track during moves. With a little remodeling the original steel chutes were used and were supported in a traveling wooden frame, one type being adopted for arches and one for inverts. The invert chute travels on a single rail and is supported so as to be heavy on the concrete-track side—just enough so that the hopper end will lie against the bank. When moves are to be made, a man leans on the opposite end of the frame, raising the hopper off the bank; padmen in the trench push the chute along where required. The discharge end of this chute has a drop end, so that the concrete can be deposited almost any place in the pad,

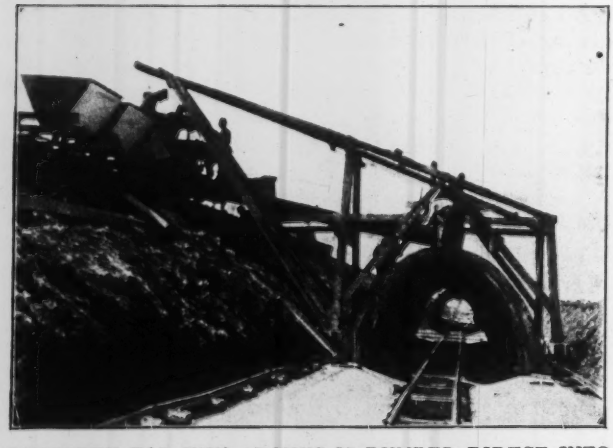


THE INVERT CHUTE TRAVELS ON A SINGLE RAIL

and requires a minimum of shoveling. The adjustments of this traveler are simply made by having the track in the trench always approximately at the same distance from the concrete track.

The traveling chutes for the arches are more complicated. They must not interfere with the form traveler, so it is necessary to have one on each side of the latter as there are no means of passing in the trench. In these arch-chute travelers the steel chutes are made in two sections, one sliding within the other; they have adjustments in all directions and are speedily controlled by means of levers and small pipe windlasses placed in convenient positions. The tail chute ends in a vertical box to which is attached by means of a pin hinge a short curved deflecting chute. The latter deflects the concrete to where it is wished to deposit it, prevents wear on the inside form and stops the concrete from spreading over the inside form and scouring off the oil.

The men working at the placing of the concrete move the traveler where required. It is always moved and in place before the next concrete train arrives, the arch being poured continuously and brought up even on both sides. With the graded gravel aggregate supplied by the district the surface finish inside is wonderfully good. In walking through portions of the completed aqueduct the reflection of the light ahead from the smooth sides gives one the idea that he is going through a polished-steel tube.



CONCRETE FOR THE ARCHES IS DUMPED DIRECT INTO HOPPER OF TRAVELING CHUTE

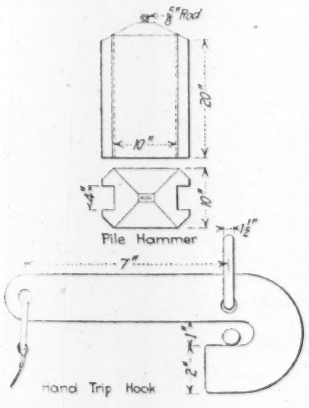
Handy Driver Rigged with Gas Engine and Hook Tripper

By R. T. BROWN
Highway Engineer, Board of Road Commissioners, Davidson County, Lexington, N. C.

AN IMPROVED piledriver run by a gasoline engine and employing a simple and safe trip, shown in the sketch, has been used with success by the writer on highway-bridge work in North Carolina. The first machine

GASOLINE MIXER ENGINE DRIVES PILES

was made by mounting a farm gasoline engine and the leads and ladder on a common bedplate, like an ordinary driver. Later, however, it was found more convenient to place the engine on an independent bed and dispense with sills entirely. The 2½-hp. gasoline engine taken from a concrete mixer was anchored down by means of a rope at the end opposite the driver; when the leads were moved, the front end of the engine was thrown over with a bar to keep the drum in line. The leads were bolted to a single sill through offset blocks and were held in the vertical position by guy ropes. The ladder shown in the picture served in getting up to the head of the pile and to reduce vibration, as the leads were 36 ft. high and spliced on one side. When leads less than 26 ft. high were used later, the ladder was taken away, which made it easier to remove the driver.



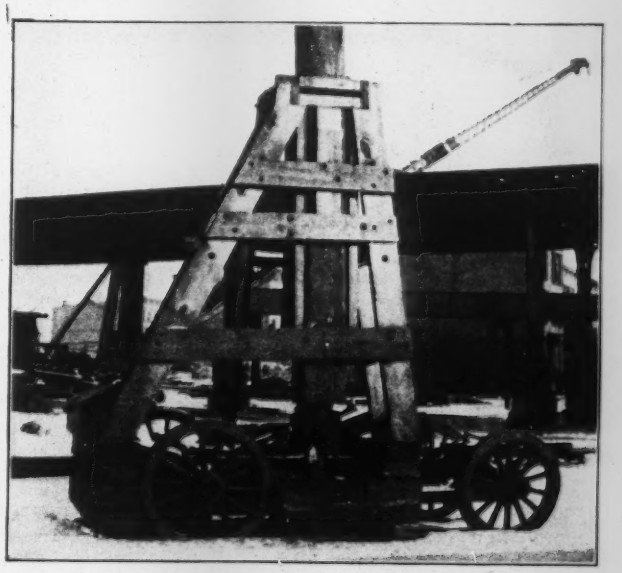
The drum was simply and effectively controlled by a belt tightener, which was merely an idler in a frame on top of the belt. The tightener could be pushed down to increase the tension in the belt to lift the hammer and could be raised to release the drum entirely for overhauling the rope.

The trip hook shown in the sketch was made from a ½ x 2-in. bar and has a very slight depression where the eye of the hammer rests. This causes the hook to hang properly and avoids accidental tripping. Although the men were afraid of this hook at first, there has never been an accident with it. The hammer can be tripped from any position in starting a pile; and if carried to the top of the leads by accident while the pile is being placed, the hammer will not be released. The trip rope is used to overhaul the hammer rope after the stroke. The hammer, which was cast in a local foundry at a cost of $10, weighs 660 lb. With a bar through the eye of the hammer it is easily handled by four men.

Jacking Wagons Used in Raising New York Elevated Prior to Third Tracking

By GEORGE D. FRIED
New York City

IN THIRD-TRACK construction on the Broadway elevated line in East New York it was necessary to raise the old structure from 2½ to 7 ft. before rebuilding, the raising being accomplished in easy stages by means of jacking wagons, one of which is shown in the photograph. In use, two wagons were placed one on each end of a bent, so that the 14 x 14-in. jacking posts could pick up the columns and floor-beam together. Before the jack was set, a timber crib on which to catch the column as it was raised was built around the column footing up to the top of the old base, usually 1½ ft. above the street surface.



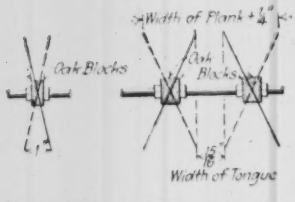
WAGON CARRIES JACKING TOWER FROM POST TO POST

These platforms were about 3½ ft. square. The trucks, after being placed, were blocked until the wheels were free, keeping the movable 14 x 14-in. post in a vertical position. The greatest distance raised at one setting of the jacking wagons was 6 in., each bent being raised from 3 to 6 in. higher than the last, which kept the old structure within the allowable grade.

The wagons could be easily and quickly moved from point to point. They were employed by Henry Mason, erection superintendent for the Crenshaw Engineering and Construction Co., Inc., which is carrying out the contract for the New York Municipal Ry. Corporation, of which A. J. Fearing is division engineer in charge of the work.

"Wabbling" Mount Enables Circular Saw To Cut Tongue-and-Groove in Sheeting

A TWENTY-INCH circular rip saw was recently adapted to make tongue-and-groove sheeting by Warren Green, carpenter foreman for the Foundation Co. at Cincinnati, Ohio. The tongue was made by taking four cuts with the saw in normal position. To cut the groove, the locknuts were taken off the arbor, and oak "wabble blocks" placed on each side of the saw, as shown in the sketch, after which the locknuts were screwed up again. In this way the saw was clamped at an angle with the shaft different from 90 deg., so that as the saw revolved, its edge wabbled over a space 1 in. wide. With this arrangement it was possible to make the groove in one cut, the only precaution necessary being to feed the saw a little slower than usual. If much of this sheeting had been required, the tongue also would have been made in one cut by putting two saws on one arbor, as indicated in the right-hand part of the sketch.



Large-Bore Drill Hole Proves Economical

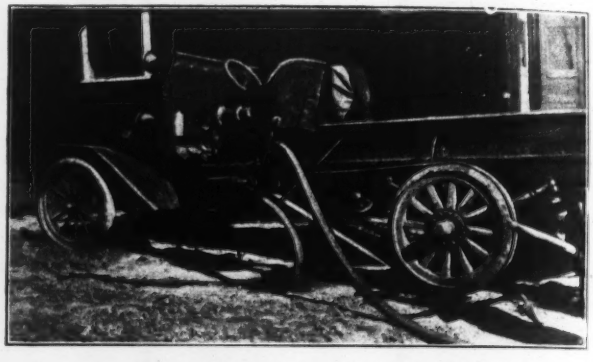
WELL drills 3½ to 4 in. in diameter enabled the engineers in charge of excavating an 1800-ft. cut on the Saline Valley R.R. to get the charge down into the bottom of the holes, thoroughly breaking up a 10-ft. layer of soft sandstone at the bottom. The road connects the coal fields of the Harrisburg (Ill.) Colliery mines with the Big Four R.R. The cut averages about 13 ft. deep, but the maximum was 25 ft. deep.

No ordinary steam drills were at hand, so two Sanderson cyclone well drills were obtained. Holes were spaced 12 ft. apart for an average bottom width of 24 ft. The average load was 45 lb. of dynamite per hole, giving an average of 1 lb. per cu.yd. of rock. As it was possible to load the large holes heavy at the bottom, the rock was broken up thoroughly and the material was all easily handled.

The additional cost of the larger holes over ordinary 2-in. holes put down with steam drills was considered by the resident engineer, J. A. Nichols, of the Big Four, as more than compensated for by the small amount of powder required—about one-half that ordinarily used per cubic yard in this district.

Mount Pump on Automobile and Drive It from Rear Wheel

AN EFFICIENT and convenient method of pumping out water ditches, manholes, meter vaults, etc., by automobile power is used by the City of San Diego, Calif. A 1½-in. centrifugal pump is bolted to the running board of one of the light trucks operated by the city, and a belt run from the pump to the rear wheel of the truck, which is equipped with a solid flat tire. The automobile jack is used to raise the wheel from the ground and the engine, controlled from the driver's seat, does the rest. When operating for any length of time care should be exercised



PUMP PLACED AT SIDE OF CAR

to see that the differential gears are well packed with grease. With the particular type of truck used, the oil in the differential case worked to one side when the car was jacked up on the opposite side, thus allowing the gears to become dry.

Tool "Telegraph Line" Saves Time on Building

By SAMUEL WARREN
New York City

THERE IS often much loss of time on a building job by workmen running downstairs to the tool shanty for small tools. A great deal of this loss can be saved by a very small outlay. If the tool shanty is alongside the building, fasten an ordinary gong to the side and stretch a small rope or heavy cord to the top story of the building. This cord can easily be lengthened as the building grows.

Then suspend another small rope or heavy cord alongside it from the top story to the ground. When a man on some floor wants a tool, he goes to the edge of the building and rings the gong on the tool shanty. His summons is answered by the toolkeeper. The workman shouts down what tool he wants, the toolkeeper fastens it to the rope, and it is hauled up. This rig can be used from any floor of the building.

This same gong is also handy when the foreman or the superintendent out on the building wants someone in the office. He can get the attention of the toolkeeper and send him to the office after the man required. If the building is very high, it is a good idea to provide megaphones both at the office and on top of the building, to carry on conversation.

NEWS OF THE WEEK

Current Events in the Civil Engineering and Contracting Fields

Indianapolis Water Rates Are Fixed by Commission

Schedule Provides for Domestic-Use Rate Reduction Amounting to Ten per Cent.

The Indiana Public Service Commission has recently handed down its report and order in the rate case between the City of Indianapolis and the Indianapolis Water Co.

The new schedule provides rate reductions of 6 to 25%. The average reduction on domestic service is about 10%. The old charge of $45 per year for fire hydrants and drinking fountains remains. Free water for park use and street washing is continued. The old meter rates, ranging from 18c. (for the first 1000 gal.) down to 4½c. (for 2,500,000 gal.), are replaced by the following schedule:

METERED SERVICE

	Rate per 1,000 gal.
For the first 7,500 gal. used monthly	$0.16
For the next 15,000 gal. used monthly	.155
For the next 22,500 gal. used monthly	.15
For the next 45,000 gal. used monthly	.10
For the next 910,000 gal. used monthly	.05
All over 1,000,000 gal. used monthly	.04

MINIMUM CHARGES

Size of Meter, In.	Monthly Use Above Which Minimum Charge Stops, Gal.	Total Charge for Use of Less Than Specified Monthly Amount
¾	7,500	$1.20
1	15,242	2.40
1½	23,000	3.60
2	37,666	5.80
3	51,966	8.33
4	157,166	16.66
6	323,966	25.00
	623,966	40.00

The case originated in 1915 with the petition of the company to issue $650,000 of capital stock to its stockholders to cover the surplus between claimed total liabilities of $11,146,490 and a total value of all property of $11,806,174. The city opposed the petition. In June, 1916, an agreement was reached between the city and the company, fixing the value of the company's property at $10,000,000 and providing a schedule of rates, locally reported to be about the same as that now fixed by the Public Service Commission. The contract became void in November, however, as the commission delayed the granting of its approval.

The value of the company's property, "used and useful," was set at $9,500,000—apparently based on a depreciated reproduction figure of $9,670,191. This sum is about midway between the commission staff's figure of $7,794,832 and the company expert's (Leonard Metcalf) $11,782,908. The staff's items were raised from 6 to 45%, and $537,125 was added for going value, working capital, recent additions and omissions. The commission's items were 4 to 40% under Mr. Metcalf's figures. A return of 7% was considered fair.

Street Caves Over Sewer

The accompanying illustration of a street cave-in over a 20-in. sewer laid some years ago at a depth of about 18 ft. in Charleston, W. Va., affords a striking illustration of the results of careless inspection of trench backfilling, in the opinion of Mayo Tolman, Director of Sanitary Engineering, State Department of Health. Mr. Tolman writes:

"The sewer was laid in a very fine silt that formed the old river bottom of the

POOR BACKFILLING CAUSES CAVE-IN

Kanawha River. I am told that the inspector was very careless generally and that when the backfill was made he did not require any tamping to amount to anything. We have had a very wet spring, and the groundwater has carried this fine silt out alongside the pipe into the river, which at this point is about 100 ft. away. A whole section of the street was thus undermined at a depth of about 18 ft. We have had several such failures in Charleston. The sewer pipe itself is still intact and in pretty good alignment. However, there is every reason to believe that it will some time be washed out.

Enlistment Authorized for New York Engineer Regiment

Colonel C. H. McKinstry, Corps of Engineers, U. S. A., commanding officer of the engineer regiment that is being organized in New York City, as outlined in "Engineering News-Record" of Apr. 12, p. 114, has been authorized by the Secretary of War to receive enlistments for the new unit. This action opens up the way for filling the ranks, for until definite orders had been received men seeking places in the engineer regiment could enroll, but could not actually enlist.

It is possible that the regiment may be called into active service in a month or so, and already a site for a training camp on Long Island is under consideration. About three-fourths of the officers needed for the new unit have been selected, and the chief efforts of Colonel McKinstry and his associates on the Military Engineering Committee are now being concentrated on filling the ranks.

Recommend Spending Sixty-Two Million in St. Louis

Public Improvements Requiring Bond Issues Thought Necessary by Engineers Committee

At the request of the Chamber of Commerce and of the Commercial Club of St. Louis, Mo., a committee of five engineers last summer volunteered to investigate the needs of the city and to report upon the public improvements which are necessary to promote its commercial and industrial progress. The committee consisted of Julius Pitzman, chairman, Frank Jonah, Baxter L. Brown, Edward Flad and M. L. Holman, none of whom is connected with the city government and all of whom served without pay. The two organizations back of the movement contributed about $2000 for the expense of the investigation.

In its report just issued the committee says that the commercial advancement of St. Louis has been retarded by (1) the high price of property available for industrial purposes; (2) lack of sufficient switch tracks, terminal facilities and team yards for handling freight; (3) lack of proper accommodation for suburban transportation; (4) excessive charges for switching within the city limits; and (5) high charges for water for manufacturing purposes. These hindrances are considered in connection with the proposals which may be itemized as follows:

Improvement of the river front	$6,600,000
An additional western approach to the Municipal Bridge	950,000
Replanning of the central part of the city	10,000,000
Drives and reservation	3,000,000
A total of about	$20,500,000
In addition, the committee indorsed the Report of the Water Commissioner for extension of the water works, amounting to	$20,000,000
Indorsed the River des Peres Plan about	8,500,000
Other items recommended by the Board of Public Service, amounting to about	10,000,000

The total recommendation was for an issuance of bonds to the extent of $62,000,000. A bill had been introduced into the State Legislature permitting an increase in the local bonded indebtedness, but this failed to pass. It is therefore possible at this time to issue only about $15,000,000. St. Louis now has an assessed valuation of approximately $700,000,000 and is limited by law to a bonded indebtedness of 5%, or at present, about $35,000,000. The actual net funded debt is now about $20,000,000.

New Charter for Cincinnati

A Charter Commission of fifteen has been elected to frame a Home Rule Charter for the City of Cincinnati, Ohio. It is expected that the new charter will retain the present federal form of government.

More Engineer Reserve Officers Appointed

Thirty Majors, 84 Captains, 42 First Lieutenants and 45 Second Lieutenants Commissioned Up to April 3

The following list of officers commissioned in the Engineer Officers' Reserve Corps, under the Defense Act of 1916, has been secured from the Chief of Engineers. It supplements the lists previously published (coming up to Mar. 15). Formal acceptances of these commissions have not yet been registered in every case.

Of the majors noted, only seven are Class A officers. (There are two groups, "Class A" for unrestricted service with combat troops and "Class B" for service in the zone of communication, etc., and for service with combat troops only in emergency.) Of the captains, 37 are of Class A and 47 of Class B. Of the first lieutenants, 31 are of Class A and 11 of Class B, and in the second lieutenants, only 10 are of Class B:

MAJORS

Mudd, Seeley W., Los Angeles, Calif.
Junkersfeld, Peter, Chicago, Ill.
Katte, E. B., Irvington, N. Y.
Betts, Philander, Newark, N. J.
Lavis, Fred, New York City
Muldrow, Robert, Washington, D. C.
Whitlock, E. H., Cleveland, Ohio
Sturtevant, C. W., Appleton City, Mo.
Buck, Richard S., New York City
Maltby, Frank B., Philadelphia, Penn.
Powell, A. O., Seattle, Wash.
Patten, W. B., Duluth Minn.
Compton R. K., Baltimore, Md.
Jacobs, J., Seattle, Wash.
Cuppy, B. W., Melrose, Mass.
Ferguson, W. H., Hazen, Nev.
Cooper, H. L., Stamford, Conn.
Dillman, George L., San Francisco, Calif.
Snyder, Frederic A., Montreal, Can.
Freeman, George W., St. Paul, Minn.
Turner, Daniel L., New York City.
Jackson, Dugald C., Boston, Mass.
Griffin, William H., Washington, D. C.
Babcock, Allen H., San Francisco, Calif.
Harroun, Philip E., San Francisco, Calif.
McGilvray, Thomas F., Duluth, Minn.
Stewart, John T., St. Paul, Minn.
Fordyce, John R., Little Rock, Ark.
Coe, Edward Kirk, Duluth, Minn.
Stiles, Arthur A., Austin, Tex.

CAPTAINS

Lamont, Clarence B., Seattle, Wash.
Parmelee, Charles L., New York City
Wild, Herbert J., Chester, Penn.
Trippe, Harry M., Whitewater, Wis.
Cowan, Edward H., Marion, Ohio
Potter, Herbert L., New York City
Delemos, Sidney P., New York City
Swan, John J., Plainfield, N. J.
Crocker, James R., New York City
Jenkins, Bertram A., Washington, D. C.
Risley, Warner L. Atlantic City, N. J.
Mandigo, Clark R., Kansas City, Mo.
Guerdrum, George H., Washington, D. C.
Zimmerman, Oliver B., LaGrange, Ill.
Akin, Albert D., Wickenburg, Ariz.
Tilden, Charles J., Baltimore, Md.
Arn, William G., Chicago, Ill.
Doyle, John B., Albany, N. Y.
Gausman, Roy W., Shandaken, N. Y.
Thorn, Wray T., Chicago, Ill.
Sharts, S. R., Dayton, Ohio
Griffin, John A., Los Angeles, Calif.
Lincoln, Paul M., Pittsburgh, Penn.
Rhoades, T. E., New York City
Hall, B. I., Port Byron, N. Y.
Irvine, V. R., Dallas, Tex.
Knapp, Arthur, Ardmore, Penn.
Chamberlain, F. G., San Antonio, Tex.
Carey, William N., St. Paul, Minn.
Melton, Arthur F., Gary, Ind
Quinlan, G. A., Chicago, Ill.
Hamilton, Orr R., Lansing, Mich.
Berliner, R. W., New York City
Pike, Albert, Washington, D. C.
McGeeham, Paul, Kansas City, Mo.
Luquer, T. T. P., New York City
Smith, Albert S., Cambridge, Mass.
Hiles, Elmer K., Pittsburgh, Penn.
Ryerson, W. N., Duluth, Minn.
Perry, F. W., Brooklyn, N. Y.
Woodard, Wilkie, Los Angeles, Calif.
Thomas, C. D., Brooklyn, N. Y.
Turner, N. B., Marshall, Tex.
Swaren, J. W., Hayward, Calif.
Moore, L. E., Newtonville, Mass.
Dallis, P. A., Atlanta, Ga.
Leland, O. M., Ithaca, N. Y.
Eck, W. J., Washington, D. C.
Van Suetendael, A. O., Yonkers, N. Y.
Muhs, L. R., Camanche, Iowa
Homes, M. G., Columbia, S. C.
Harmon, Burt, Los Angeles, Calif.
Whipple, R. I., Worcester, Mass.
Manierre, G., Milwaukee, Wis.
Morris, J. M., Los Angeles, Calif.
Meddaugh, S. A., Lakewood, Ohio
Gregory, W. I., Louisville, Ky.
Hite, M. P., Washington, D. C.
Shepard, G. M., Minneapolis, Minn.
Strecker, R. A., Louisville, Ky.
Hodgeson, H. H., Washington, D. C.
Brownell, O. E., Duluth, Minn.
Yost, H. M., Massillon, Ohio
Ilg, G. M. A., Chicago, Ill.
McAlpine, William H., Louisville, Ky.
Bush, Philip L., San Francisco, Calif.
Miller, George S., Minneapolis, Minn.
Grant, Kenneth C., Dayton, Ohio
Starrett, William A., New York City
Reeves, Carl H., Seattle, Wash.
Elrod, Henry E., Dallas, Tex.
Cameron, Harry F., Union, Maine
Greene, Frederick S., New York City
Brooks, Alfred H., Washington, D. C.
Post, William S., Los Angeles, Calif.
Wilbur, Ralston T., Spokane, Wash.
Finley, Charles MacF., Sioux City, Iowa
McNair, Eugene L., Washington, D. C.
Anderson, Frederick C., Carthage, N. Y.
Calrow, Charles J., Norfolk, Va.
Kess, George W., Des Moines, Iowa
Kendall, Clyde B., Washington, D. C.
McHenry, Wallace E., St. Louis, Mo.
Turley, Jay, Santa Fe, N. M.

FIRST LIEUTENANTS

DuBois, George B., Washington, D. C.
Robbins, F. S., Edgewood, Penn.
Archibald, E. F., Pittsburgh, Penn.
Dunn, Theodore S., DuBois, Penn.
Rowlands, R. A., Minneapolis, Minn.
Randall, N. W., Hatch, N. M.
Dale, Harry L., Findlay, Ohio
Pierce, C. H., Washington, D. C.
Arkenburgh, W. H., Schenectady, N. Y.
Bader, Ralph D., Yellowstone Park, Wyo.
Ackerman, A. S., Newport, R. I.
Rook, Ross Henry, Los Angeles, Calif.
Bartlett, C. C. Corona, Calif.
Sleppy, Kirby P., Los Angeles, Calif.
Fassett, Earl W., Los Angeles, Calif.
Hurlburt, C. M., Hood River, Ore.
Schliewen, E. E., Los Angeles, Calif.
Growdon, J. P., Portland, Ore.
Shallcross, W. M., Milwaukee, Wis.
Wilder, Harry C., Malone, N. Y.
Hohn, Emil, Brooklyn, N. Y.
Ferebbe, James L., Milwaukee, Wis.
Knauff, F. H., Atlanta, Ga.
Comstock, J. Walter, Pittsburgh, Penn.
Breed, Charles W., Western Springs, Ill.
Jones, H. A., Jr., Montgomery, Ala.
Skinkle, W. B., Coraopolis, Penn.
Coleman, E. H., New Orleans, La.
Richers, G. J., Pittsburgh, Penn.
Graeter, G. C., Sullivan, Ind.
Crockett, R. E., Brooklyn, N. Y.
Ralston, L. T. M. Evansville, Ind.
Wood, C. P., Metuchen, N. J.
Grunert, A. E., Chicago, Ill.
Hock, H. L., Goshen, N. Y.
Vogel, R. R., Cleveland, Ohio
Blakeslee, D. W., Irwin, Penn.
Knerr, L. E., Chicago, Ill.
Benedict, E. G., Waterbury, Conn.
Ehrenrich, S. B., Utica, N. Y.
Wilkinson, H. W., Dwight, Kan.
Templeton, R. J., Chattanooga, Tenn.
Glasgow, L. B., Lakewood, Ohio
North, M. S., Calumet, Mich.
Maxwell, Alexander, New York City
Mims, Leslie W., Salt Lake City, Utah
Lewis, Walter H., New York City
Cutting, Geo. W., Jr., Auburndale, Mass.
Capelle, George C., Watertown, Mass.
Marshall, Jamieson, Yonkers, N. Y.
Kammerman, Jno. O., State College, Penn.
Boggs, Clarence E., Vale, Ore.
Hartwell, Oliver W., Albany, N. Y.
Bickford, John W., Bens Run, W. Va.
Ridenour, Claude A., Dallas, Tex.
Rhodes, William S., Roslindale, Mass.
Austen, Earl Stanford, North Tonawanda, N. Y.
Penick, Stuart T., Washington, D. C.
Stein, Jacob, Indianola, Miss.
Perry, Lynn, Trenton, N. J.
Smith, Horace L., Jr., Petersburg, Va.
May, Richard B., Dayton, Ohio
Wills, Clarke W., Fort Worth, Tex.
Stanton, Raymond L., Philadelphia, Penn.

May Combine Jersey Sewerage and Water Districts

The practicability of consolidating the Passaic Valley District Sewerage Commission and the North Jersey District Water-Supply Commission is to be investigated by a commission of three citizens to be appointed by Governor Edge in accordance with an act passed by the legislature. The investigation may be made either "separately or in conjunction with the governor." The commission is to report to the legislature of 1918 "whether or not it will be in the interest of economy and efficiency" to effect such a consolidation and "also whether such consolidation is legally and otherwise practicable of accomplishment." The Passaic Valley Sewerage Commission has been engaged for some years past in constructing a joint trunk sewer from Paterson to Newark, with treatment works and a pumping station on the meadows and an outlet tunnel beneath Newark Bay, the Bayonne peninsula and New York harbor. The North Jersey District Water-Supply Commission was created a year ago to take over that part of the work of the former State Water-Supply Commission pertaining to northern New Jersey. The taking of new sources of water-supply in the district is subject to approval by the commission. In addition, the commission is empowered to co-operate with municipalities in building works for the joint water-supply of several municipalities. No project for a joint water-supply under the commission has yet gone beyond the preliminary stage.

City- and Town-Planning Activity

City plans are to be made for Niagara Falls, N. Y., Flint, Mich., and Charlotte, N. C., by John Nolen, of Cambridge, Mass. On the Niagara Falls plans, E. P. Goodrich, of New York City, will act as expert on railroad and street-railway matters; and on the Flint plans, Bion J. Arnold, of Chicago, will serve as transportation expert. Mr. Nolen is also preparing plans for industrial settlements at Allwood, near Passaic, N. J., for the Brighton Mills; and near Marcus Hook, N. J., for the General Chemical Co. Near Waterbury, Conn., Mr. Nolen is to plan Green Acres, including a village center, store sites, recreation and residence areas.

Positions for Engineer Officials in Illinois

Under the new Illinois law that provides for consolidation of the various and numerous state departments, there are several offices which are not included in the civil-service system, but are to be filled by appointment of the governor. Governor Lowden has already appointed a lawyer—Judge Puterbaugh, of Peoria—as director of the Department of Public Works; the salary of this position is $7000 per year. Other offices that have duties directly or indirectly related to engineering are as follows:

Departments Which Need Men

Department of Public Works—Assistant director, $4000; superintendent of highways, $5000; chief highway engineer, $5000; supervising engineer, $4000; superintendent of waterways, $5000; three advisory boards of five members each (without compensation) for highways, water resources and parks and buildings. The Department of Public Health is to have a similar board of health advisers. Department of Mines and Minerals—A director and assistant director, at $5000 and $3000; and a mining board of five members at $500 each. Department of Labor—Chief factory inspector, $3000. Department of Trade and Commerce—Five members of a utility commission at $7000 each, and a superintendent of standards, $2500. Department of Registration and Education—Superintendent of registration, $4200; and a board of seven advisers in natural resources (without compensation), one of whom is required to be an "expert in engineering." The director of this department has the appointment of a board of seven examiners of structural engineers (for licenses), which board includes (ex officio) a professor of civil engineering at the University of Illinois.

Pittsburgh Bridge Raising Ordered To Begin at Once

Specific orders for reconstruction of the Allegheny River bridges at Pittsburgh have been issued by the War Department, following the decision of Newton D. Baker, Secretary of War, that the bridges are an unreasonable obstruction to navigation. Reconstruction of the Pennsylvania Lines bridge (Pittsburgh, Fort Wayne & Chicago R.R.) and the county's bridges at Sixteenth and Forty-Third Sts. is ordered to begin at once and to be completed within one year for the railroad bridge and 2½ years for the other two. Work is to begin on the Seventh and Ninth St. bridges in 1½ years, on the Sixth St. bridge in 2½ years, and on the Thirteenth St. bridge in 3 years, each bridge to be completed in two years' time. The clearance heights called for are, in feet above Davis Island pool level: Sixth St., 47; Seventh St., 47.1; Ninth St., 47.5; Pennsylvania, 47.5; Sixteenth St., 48.2; Thirtieth St., 51; Forty-third St., 51.

William A. Russell To Investigate Russian Conditions for United States

William A. Russell, a consulting engineer, of New York City, has been appointed by the Bureau of Foreign and Domestic Commerce as a special agent to investigate opportunities for American engineers and manufacturers in Russia, and leaves for Petrograd this week.

Mr. Russell has unusual qualifications for success in this field. He is a native of Russia, having been born in Petrograd in 1877. He graduated from the Government Engineering School in Petrograd in 1900, receiving the highest technical degree conferred by any technical institute in Russia, the degree carrying with it the license to undertake responsible work under the Department of Roads and Communications.

Commercial Representative of the United States in Russia on Behalf of the Bureau of Foreign and Domestic Commerce

WILLIAM A. RUSSELL

During the next half-dozen years Mr. Russell was engaged on various engineering works in Russia and Siberia, including railway and highway construction, manufacturing industry, etc. He took part in the Russian expeditionary force to China during the Boxer uprising, and assisted in the reconstruction of the railway from Tientsin to Peking.

In 1906 Mr. Russell came to the United States, and after working a year or more in connection with the Pennsylvania tunnels under the East River and in the Valuation Department of the New York, New Haven & Hartford R.R., he specialized in scientific investigation and efficiency work. He was for a year expert consulting engineer to the Board of Estimate and Apportionment of New York City, co-operating with Harrington Emerson. Since 1911, as the senior member of the firm of M. W. Thompson & Co., of New York City, he has carried on many important investigations for bankers, business firms and railway companies.

While Mr. Russell's mother was Russian, his father was of English parentage, and he speaks English, Russian, French and German equally well.

Rapid Transit in Cincinnati Assured by Vote

The proposed rapid-transit improvements at Cincinnati, Ohio, which have been projected for about two years, are assured by the special election of Apr. 17, 1917, when a vote in a proportion of 2 to 1 was cast in favor of ratifying the lease drawn up between the city and the local traction company for the operation of the new line. Work preparing plans, estimates and specifications covering the special engineering features will be promptly proceeded with, and by Jan. 1, 1918, it is expected to have a number of contracts ready for the receipt of bids.

The total length of the "Loop" will be about 16 miles, of which about 3 miles will be subway, 3 miles elevated and the balance at grade. It will be a two-track system of standard gage and will provide the means by which the interurban lines, which are now compelled to discharge their passengers and freight near the corporation limits of the city, may have their terminal at a central depot in the heart of the city. Bonds in the amount of $6,000,000 had previously been authorized for its construction.

Concrete Bridge Patent Held Invalid in Equity Suit

An infringement suit brought by Walter Sharp, holder of U. S. Patent No. 885,386, "for new and useful improvements in bridge construction," against the County Commissioners of Butler County, Kansas, was dismissed on Apr. 5, 1917, by Judge Pollock, of the United States District Court, District of Kansas, Second Division, "for want of equity because of the invalidity of the patent on its face." The patent, granted Apr. 21, 1908, is for a reinforced-concrete girder bridge in which the wire-net reinforcement of the floor extends upward through the parapets or in which rods in the beams "project through the . . . abutments into the . . . floor."

The county applied for a writ of dismissal on the ground that the claims of the patent are void for lack of invention and for want of novelty at the date the patent was applied for. The judge ruled that the court could take judicial notice of the state of the art of building reinforced-concrete bridges, and that the patent did not involve anything new to that art. He therefore dismissed the case for want of equity.

"New Mexico," First Electric Battleship. Launched

The superdreadnought "New Mexico," first of the trio of greatest American battleships to take the water, was launched at the Brooklyn Navy Yard, New York City, on Apr. 23. She is 624 ft. long, will have a displacement of 32,000 tons and a maximum speed of 19 knots. She will have twelve 14-in. guns and will carry 1150 men and officers.

The feature of greatest interest to engineers is the use of the so-called electric drive—steam turbines driving generators that feed current to motors on the propeller shaft. Contracts were let for this equipment in 1914, while the vessel still bore the name "California," which later was changed to "New Mexico." The selection of this drive is attributed to the success of the only naval vessel previously equipped, the collier "Jupiter," of 19,300 tons. While details are not available, it was reported at the time the contracts were let for the "New Mexico" that there would be two high-speed steam-turbine alternating-current generating units, and four induction motors—one on each propeller shaft. There were to be two engine rooms, but all four motors were to be run from one turbine unit, except at speeds above 15 to 19 knots. No starting or backing resistance was required for the motor, as a new type had been developed for such service, having a double squirrel-cage winding on the rotor. The outer layer of conductors was of high resistance, and the inner layer of low resistance; for starting and backing, the inner conductors took little current, while the outer ones gave high torque. As the speed was increased the inner cage of conductors came more into action and ordinary induction motor conditions prevailed. Pole changing windings were used to secure further possible speed reduction between turbines and screws.

Waterway To Carry Illinois Coal Traffic

A navigable waterway for barges from the southern Illinois coal fields to the Mississippi River is proposed by the Illinois Rivers and Lakes Commission to assist in the development of this extensive district. The general plan is to build a dam and lock in the Big Muddy River at Sand Ridge, and below this to cut a canal to the Mississippi River at Fountain Bluff, with a second lock at the river and a spillway to regulate the depth of water in the canal. The length of the canal would be 6½ miles, while the Big Muddy below Sand Ridge follows a tortuous course of 30 miles before it reaches the Mississippi. Above the dam the river would be improved by a small amount of dredging and making three cutoffs to eliminate sharp bends or loops in the river channel. This plan would give a navigable waterway for about 55 miles, to near Plumfield.

The dam would be built at a point where the river is narrow, with high and steep rocky banks and a bedrock bottom. It would be about 320 ft. long and 25 ft. high. For the canal a bottom width of 70 ft. is proposed, with side slopes of 2 on 1 and about 8 ft. of water. The excavated material would form levees or dikes to protect the canal during flood stages in the Mississippi. Drop culverts would carry drainage ditches and small streams under the canal. The locks are to be 310 x 45 ft. For the one at the Mississippi the lift would be about 30 ft. For the other it would be only about 2 ft. at ordinary stages, while during low water the gates might be left open.

The estimated cost is as follows: Dam, spillway and two locks, $595,000; canal (including connection to Kincaid Creek), $185,000; improving river above dam, $60,000. This makes $840,000 for construction, while land damages would bring the total cost to about $990,000. The project is recommended by the Rivers and Lakes Commission in a report to Governor Lowden, and plans and surveys have been made by G. W. Stickney, chief engineer for the commission.

Speeding Up Irrigation on Reclamation Projects

To speed up the utilization of land in the various projects of the United States Reclamation Service, two plans are being pushed by Secretary of the Interior Lane.

One of these "proposes that there be organized at once on each project a War Maintenance Corps," each company of which would be provided with "as many gang plows and harrows and seeders as can be bought or borrowed." Around these the farmers would be organized like soldiers around a field gun. Each company of men and farm machines would complete its job on one farm in a rush and move on to the next. The same general plan would be followed throughout the season until the end of harvesting.

The second plan is embodied in a Congressional bill to stimulate food production within reclamation projects, as follows: (1) Making it possible for the Reclamation Service to supply water to private lands within but not part of reclamation projects until Dec., 31, 1920, at a cost not less than the usual operation and maintenance charge plus 2% of the construction charge. (2) Authorizing the lease of public lands within reclamation projects, also authorizing the supply of water thereto as under (1), plus a land charge. (3) Authorizing the Secretary of the Interior to get public lands under cultivation by contract or by Government forces, wherever it proves to be impracticable to secure irrigation and cultivation otherwise. (4) Authorization, as under (3), to put under cultivation privately owned lands, the private owners to be compensated, but with deductions for benefits due to leveling, ditching, fencing, etc., done to bring the lands under cultivation.

The bill carries an appropriation of $5,000,000, to be reimbursed to the general fund of the Treasury from the sale of crops or from any other receipts into the reclamation fund due to operations under the proposed act.

Commission Will Study European Needs for American Lumber

A commission of four members has been appointed by the Bureau of Foreign and Domestic Commerce to estimate the amounts of American lumber that will be needed in Europe for reconstruction purposes. The investigation is to be financed jointly by the bureau and the National Lumber Manufacturers' Association, the association paying the expenses of three of the commissioners.

The appointees are now preparing to visit every lumber-producing center in the United States, the object being to get in closest touch with all lumber concerns who are interested in foreign trade. In Europe they will study the districts that will be in greatest need of lumber as soon as peace is made, will ascertain the kind of lumber that will be in demand and will estimate the nature of the competition that will be encountered. It is thought that the investigation will require two years, but reports will be made as frequently as possible and will be published as soon as they arrive in Washington.

John R. Walker, of Washington, D. C.; Nelson C. Brown, of Syracuse, N. Y.; Roger E. Simmons, of Hagerstown, Md.; and A. H. Oxholm, of San Francisco, constitute the commission. Mr. Walker, in addition to practical experience in the lumber industry and considerable exporting experience, has appeared before the Interstate Commerce Commission in behalf of every branch of the lumber business. Mr. Brown took part in a previous investigation of the lumber markets of Europe in a private capacity and has been connected recently with Syracuse University and the United States Forest Service. Mr. Simmons began in the lumber business as a partner in a Maryland lumber company. He was connected with the United States Forest Service for a number of years and recently completed an investigation of the lumber markets of South America in behalf of the Bureau of Foreign and Domestic Commerce. Mr. Oxholm is a native of Norway and had a thorough knowledge of the Baltic lumber industry before coming to this country, and he has been in the lumber business since coming here.

Open Corona Extension of New York's Transit System

The Corona elevated extension of New York's dual rapid-transit system was put into operation Apr. 21. This is a three-track structure, 4¼ miles, and will connect with other Queens lines at the Queensboro Bridge Plaza station.

On To Richmond for Water-Works Convention, May 7 to 11

The slogan of the American Water-Works Association is "On to Richmond" to accept the hospitalities of that city repeated and eloquently offered by E. E. Davis, superintendent of the Richmond Water-Works. Bright and early Monday, May 7, Secretary John M. Diven will open his office at The Jefferson. At 10 a.m. the Executive Committee will get busy. Through the day standing and special committees will have rooms assigned them for meetings to consider reports.

At 8:30 Monday evening President Leonard Metcalf will deliver his annual address. After that informal "talks" by members and a general "get together" will be in order. During the next four days 35 papers besides numerous committee reports are scheduled for presentation. Among special features of the program are a group of four papers on pumping stations, Tuesday afternoon; a Water-Works Manufacturers' Association excursion to the Richmond Country Club, Wednesday afternoon, with golf and other attractions; Superintendent's Day—a hard-working three-session day—on Thursday, with two sessions of the Chemical and Bacteriological Section as a counter attraction; reports of special committees in the forenoon of Friday, and a City of Richmond excursion to the water-works settling basins and pumping station in the afternoon. Throughout the week a variety of entertainment will be offered to the ladies who accompany the members to Richmond.

Ship Draftsmen Urgently Needed

Ship draftsmen are urgently needed by the U. S. Navy Department. With millions of dollars available for new construction, writes John A. McIlhenny, President of the U. S. Civil Service Commission, all shipbuilding work undertaken at Government yards is retarded by the shortage of ship draftsmen. The commission is therefore announcing a nonassembled examination in which applications will be received any time until further notice. Papers will be examined immediately upon receipt, ratings will be determined and those qualifying will be employed at once.

There are four grades—grade 1, $3.28 to $4 per diem; grade 2, over $4 to $5.04; grade 3, over $5.04 to $6, and grade 4, over $6. For grade 1 candidates must be graduates of reputable technical schools, with one year's experience in shipbuilding; or must be graduates of or seniors in a naval architecture course at such reputable school; or must have had three years' experience in shipbuilding, including a year in the drafting room. Grade 2 requires two more years' experience in ship drafting (one year only for graduates in naval architecture). Grade 3 requires two more years, in which the candidate must have been on original work of a general character under nominal supervision. Grade 4 requires in addition a year in a supervisory ship-drafting position.

Prospective candidates should apply at once to the U. S. Civil Service Commission, Washington, D. C., or to the commission's representatives at various large cities. They should ask for Form 1312 and state the title—"Ship Draftsman (Male)"—of the examination desired.

Meter Company Grants Eight-Hour Day

The Neptune Meter Co. announced to its employees this month that it had voluntarily granted them an eight-hour working day. This announcement was made by J. Herbert Ballantine, president of the company, at a ceremony attendant on the raising of a great American flag over the factory.

All-American Canal to Imperial Valley Not Feasible

At the request of Federal authorities, Elwood Mead, D. C. Henny and Joseph Jacobs have made a report to the Department of the Interior on the feasibility of certain changes in the Imperial Irrigation System desired by landholders in the district served. The report states that an all-American canal is impossible, that the Federal Government is the logical agency for complete development of the canal and flood-protection systems necessary and that connection with a supply canal from the Laguna dam is a desirable move.

"Government action is necessary," the report states, "for the protection of a million acres of American lands in the Imperial Valley and 80,000 acres of Yuma project lands. Because of mutual interference and the reflex effect of levees on opposite sides of the same stream, the levee system should be handled as a political problem and all work upon its several units should be co-ordinated to a common plan." The Federal Government is the only agency, it was pointed out, "that can develop the complete system of flood-protection works required by the Colorado River delta region."

Unified Levee Control

A unified political control of levees protecting both Yuma and Imperial projects is recommended, and it is suggested that even at this late date the best plan would be to endeavor to arrange by treaty for the shifting of the international boundary line southward far enough to place the levees and the entire main canal within the United States. Or, failing in this, the negotiation of a treaty that would provide for freedom of intercourse in the territory involved for construction, maintenance and operation of irrigation and protection works.

Since Imperial Valley water-supply comes from seven states, in all of which irrigation is essential to success in agriculture, a fair and equable policy of control and apportionment should be decided upon promptly. Otherwise, experience has shown that costly interstate litigation will be one of the inevitable results, entailing not only an enormous expense, it is pointed out, but providing neither a final nor a satisfactory solution. The plan, therefore, should be for the irrigation development of the river as a unit and should be prepared under the direction of the Federal Government and in co-operation with the authorities of the different states.

As the first step toward such comprehensive administration of the stream, it was suggested that the Secretary of the Interior request each of the several states involved to appoint a representative to confer with representatives of the Federal Government in an endeavor to formulate a plan for the unified control of the stream.

Married Men Eligible to Civil Engineering Corps of Navy

In the notice published in "Engineering News-Record" of Apr. 19 regarding the examination to fill existing vacancies in the grade of Assistant Civil Engineer, Corps of Civil Engineers, United States Navy, it was erroneously stated that only unmarried men were eligible. The Bureau of Yards and Docks reports that marriage will not militate against a candidate's eligibility.

No Department of Public Domain for Minnesota

The bill for merging nine Minnesota boards and commissions in a Department of Public Domain with five bureaus (detailed in "Engineering News," Feb. 15, 1917, p. 293) was lost in the senate by a single vote. The house bill to the same end was then amended at the request of Governor Burnquist, so as to eliminate the department director, but leave the five bureaus, these to be under the governor. The house passed the bill in this form, but it was held back by senate opposition and finally "lost in the shuffle" of the last hours of the session. Three of the five proposed bureaus were: Highways, Mines, Drainage and Water.

Oakland Bridge Would Be Obstruction

Projects for building a bridge across San Francisco Bay are not viewed favorably by the War Department. An opinion given by Gen. William M. Black, Chief of Engineers, U. S. Army, says that a tunnel is preferred for direct rail connection between San Francisco and Oakland. South of Hunters Point a high fixed bridge would be considered allowable—with clear span of at least 1800 ft. and clearance height of 210 ft. on 800-ft. width—while south of San Mateo a low bridge could be built.

International Good-Roads Congress at Ottawa

A Number of Engineers from the United States Read Papers and Participated in the Discussion

The fourth Canadian and International Good-Roads Congress was held at Ottawa, Apr. 10 to 13, with an attendance of about 300 delegates, including a large number from the United States. The opening address was delivered by the Duke of Devonshire, governor general of Canada. A number of technical papers were presented. W. A. McLean, deputy minister of highways for Ontario, reviewed the highway laws of the province and gave details of the system. Col. William D. Sohier, chairman of the Massachusetts Highway Commission, read a paper on "Bituminous Macadam Roads," pointing out the effect of motor trucks on roads. A discussion arose from the reading of a paper on "Road Drainage and Foundations," by George Hogarth, chief engineer of the Ontario Public Highways Department, who contended that the whole problem of the improvement and maintenance of roads rested with drainage. Those who took part in the discussion were Colonel Sohier, Mr. McLean, B. Michaud, deputy minister of highways for Quebec; F. Bray, Ottawa; and James H. MacDonald, ex-state highway commissioner of Connecticut, the latter thoroughly favoring the English rubble drain and Telford base.

Mr. MacDonald dealt with the construction and maintenance of gravel and macadamized roads. A. Fraser, of Quebec, spoke of the necessity of correcting alignment and grades on existing highways. R. B. Morley detailed the efforts of the Ontario Safety League to inculcate habits of carefulness. Papers were read by D. T. Black on "Brick Pavements," and by W. H. Connell, of Philadelphia, on "Granite-Block Pavements." L. Reinecke, of the Canadian Geological Survey, indicated the work that is being done in making surveys of road materials available along the route of proposed highways.

Thomas Adams, town-planning expert of the Commission of Conservation, talked on the relation of highways to town planning, which was discussed at considerable length. A complete road exhibit showed the methods of road improvement and the machinery and implements used. The processes of laying bitulithic, concrete and asphalt pavements were shown by designs and models.

Foundation Company Builds Large Concrete Cylinders

The large concrete cylinders for the condenser wells of the new power station of the Union Gas & Electric Co., at Cincinnati, Ohio, illustrated on the front cover of last week's "Engineering News-Record," were built by the Foundation Co., of New York, to whom credit should have been given.

Free Banquet to Paid-Up Members

The Detroit Engineering Society has hit upon a unique scheme for increasing attendance at its annual dinner and at the same time insuring early payment of dues. These dinners are both elaborate and free, but admission is given only to those who have paid their annual dues. The scheme has proved effective in bringing delinquents to scratch, but experience shows that the scramble the last minute to pay dues in order to secure entrance to the banquet has crowded out many of the dependable members who pay their dues and go to the banquet on time, only to find all seats filled. This year those who have paid by a fixed date will receive blue tickets, which give admittance to the dinner up to the time of starting. Those members who pay dues after that date receive red tickets, which give admittance to the dinner after the time of starting.

Texas Highway Law Signed

Board of Road Commissioners Created and Autos Taxed

The law recently passed in the Texas legislature provides for a Board of Road Commissioners who are to serve at a per diem and expenses. In co-operation with the counties of the state the commission will have the power to make plans for the location, construction and maintenance of a comprehensive system of state highways. The state highway engineer, appointed by the commission, shall be a competent civil engineer and a graduate of an accredited school of engineering and must have had experience in highway construction and maintenance. His salary is to be set by the commission, but it must be "adequate."

Counties Must Co-operate

Within 12 months after the pasage of the act, every county must prepare a road map showing the approximate location of all public roads within the county. All other information that may be of benefit or value in road construction must always be shown on these maps. After these data have been completed the State Highway Commission is charged to do all that lies in its power to advance the construction of the roads known as the state highways. When designated state roads are constructed according to specifications and under the supervision of the state highway engineer, the commission shall make an allotment of aid from any moneys in the state highway fund, not to exceed one-fourth the cost of construction. The state is not allowed to aid in the construction of more than 10 miles of road in any county during any one year.

The laboratories of the Agricultural and Mechanical College and of the University of Texas are made available and placed at the disposal of the state highway engineers for the purpose of ing and analyzing road materials

Registration Fees for Automobil

All owners of motor vehicles st register with the department. Pleasure automobiles are taxed at 35c. per hp., with a minimum fee of $7.50. Commercial vehicles are rated upon the carrying capacity per wheel, as follows:

Weight in Pounds per Wheel	Fee
1,001 to 2,000	$20
2,001 to 4,000	40
4,001 to 6,000	60
6,001 to 8,000	150
8,001 to 10,000	300

Each additional 1000 lb. in excess of 10,000 lb. per wheel is to cost $500, and no greater load than 800 lb. per inch width of tire per wheel shall in any case be permitted.

Southern Pacific Loses $30,000,000 Land Suit

By a decision rendered Apr. 23 the United States Supreme Court has sustained the Oregon Federal Court in enjoining the Southern Pacific Co. from disposing of timber and minerals on the lands received by the company in 1866 by Government grant. The Chamberlain-Ferris law of 1916, divesting the railroad of its title to these lands, was upheld as constitutional, and the Government regains nearly 2,300,000 acres in Oregon and Washington, valued at $30,000,000.

The decision entailed forfeiture of the railroad's title to land, timber and minerals, with future payment to the railroad of $2.50 an acre for the land only; denial to the road of any proceeds from timber or minerals; disposition of timber, minerals, power and agricultural rights under the direction of the Departments of Agriculture and the Interior, and payment to the States of Oregon and Washington of about $1,300,000 in taxes.

Forfeiture of the railroad's title was based on the assertion that the company had charged more for the land it had disposed of than the $2.50 per acre allowed by the grant. The Government alleged gross and continuous violation of this price restriction for 40 years.

Iowa Highway Commission Law Is Vindicated

The law creating the Iowa State Highway Commission of three men who appoint the state highway engineer and a considerable force of engineers under him has been under severe fire during the present session of the legislature. The main opposition seemed to emanate from the camp of certain material men whose interests were being interfered with. This victory for better roads is traceable to the fact that the present system has accomplished excellent results in the few years since it was put into operation. All attempts to abolish the commission or to change its location or make-up or to impair its authority were defeated—even in the

House, where the reactionaries felt they had a large majority.

A bill accepting Federal aid also has passed both branches of the assembly. The expenditure of such moneys is placed under the jurisdiction of the State Highway Commission. About $2,200,000, taken from automobile-license receipts, was provided to extend the state-road system. Another law requiring patrol system of maintenance on all county highways has been passed. Some 16,000 miles of these roads are to be divided into sections, each under constant care of a patrolman.

Defects in the Chicago Municipal Pier Are of Minor Importance

Reports of defective conditions in the buildings on the new municipal pier at Chicago have led to an inspection by the engineers of the Department of Public Works, which shows that the defects are in concrete filling and flooring and do not affect the structural work. The buildings are of steel-frame construction, with concrete casing for all steel and a concrete floor for the upper deck.

On 60 of the outer columns the casing was found to show a layer of loam and clay, then a layer of partly set cement ruined by laitance, and then a much thicker deposit of stone and sand washed almost free of cement. This condition is stated to be due to the fact that the concrete casing of the fascia girder above was poured at the same time as the columns, with the result that the water washed impurities from the girder into the columns, depositing the mud and cement and then stone and sand, as found. None of the interior columns show this trouble, as the concrete casing was poured independently of the floor slab above them. The complete renewal of the casing in the columns affected is recommended. Mortar patches would soon be shaken out when the pier is in use, as the columns are then likely to be struck frequently by loaded hand-trucks.

The other class of defect consists of expansion cracks in the roof of the dock-level portion of the freight sheds. These cracks are due to improper design of expansion joints in the concrete upper floor, over the steel longitudinal and transverse floor-beams. The joints did not allow for the motion of the slab above, but forced it to crack away from the lower concrete that incases the steel beams. The only trouble from this is that where the crack occurs at the bottom of the beam there may be liability of pieces of concrete casing falling down. In such cases (on 40 beams) the casing concrete is to be bolted through the beams and cut loose from the floor slab above. Where the crack is at the top of the beam, this is not necessary. It is recommended that the longitudinal floor-beams should be cut loose from the columns, so that in contracting they will not be liable to pull out pieces of concrete.

The total cost of the repair work on concrete filling and plastering, including bolts through cross-girders, is estimated at $2500. The pier is 3000 ft. long and is not only subjected to severe temperature changes, but is exposed to the full force of storm and wind.

Seven Billion Dollar Loan Bill Signed by President

The great war finance measure, authorizing the issue of $5,000,000,000 in bonds and $2,000,000,000 in treasury certificates, passed both houses of Congress Apr. 23, and was signed by President Wilson on the next day.

The treasury certificates bear 3% interest and are to be issued as needed. They will serve to create a circulating fund, the amounts realized by their issue from time to time probably being spent immediately and thus returned to circulation. The first issue is for $200,000,000 and will be put out at once; they will run to June 30 and will be retired by income from new taxes to be levied or will be exchanged for parts of the bond issue.

The bonds will bear 3½% interest; the term has not yet been definitely fixed, this being left to the Secretary of the Treasury. It is expected that the term will be 20 or 30 years, with some provision for quicker retirement. The announced plans are to put them out in instalments of such size and at such intervals as are dictated by the ability of the country to absorb them without disturbance to business. The first lot is expected to appear about July 1. Of the funds realized from the bond issue, it is reported that $3,000,000,000 will be used as a loan to European governments and that $2,000,000,000 will be required to finance American war preparations.

Will Meet in Twin Cities

It has been announced that the summer meeting of the American Society of Civil Engineers will be held in the "Twin Cities," Minneapolis and St. Paul, June 12 to 15 inclusive. The headquarters will be at the Radisson Hotel. It is proposed to spend the last day of the three in Duluth and on the Iron Range. In order that there should not be any invidious distinction, it was agreed that St. Paul and Minneapolis should share equally in the honors, so that the name "Twin Cities" is used with a purpose.

Provides for Minimum Width of 16 Ft.

Under the provisions of a bill just presented to the state legislature of Pennsylvania, it will be unlawful to construct or maintain any highway in the State of Pennsylvania which has not at least 16 ft. of its width in such condition that a horse can travel with safety. No state or county money shall be appropriated for road construction or maintenance unless this provision is met.

35,000 Reserve Officers Will Be Trained at 14 Camps

Officers for New Army Units To Get Intensive General and Special Instruction for Three Months

The War Department has established 14 camps for training 35,000 selected men as army officers. About 10,000 of these men will be placed in the field, after the three months' instruction is completed, for training the first 500,000 recruits expected to be raised by August for the new army units. The 25,000 trained officers thus left will be appointed to the Officers' Reserve Corps, if not already commissioned.

The camps have been located at vacated army posts on account of the lack of tentage. The 14 places are Fort Ethan Allen, Vt.; Plattsburg, N. Y.; Madison Barracks, N. Y.; Fort Niagara, N. Y.; Fort Meyer, Va.; Fort Oglethorpe, Ga.; Fort McPherson, Ga.; Fort Harrison, Ind.; Fort Sheridan, Ill.; Fort Root, Ark.; Fort Snelling, Minn.; Fort Riley, Kan.; Leon Springs, Tex., and the Presidio at San Francisco. These are the most convenient posts in the 16 divisional areas of the proposed new army plan which has been before Congress. Camps will be ready May 1 and the instruction will begin May 8. The maximum attendance at a camp is limited to 25,000. The age limits are 20 yr. 9 mo. to 44 yr. Preference will be given to the more mature and experienced men, for as the second 500,000 recruits come up for training many of the first officers will be promoted.

No Provision, as Yet, for Pay

Reserve officers of the line and engineers, commissioned under the Defense Act of 1916, have been urged to go to these camps, but have not been ordered "in the absence of specific authorization and appropriations," states the Adjutant General. Reserve officers and selected citizens alike get travel, subsistence and equipment, but no pay. Much complaint has been heard, in army circles and out, that this would result in the officers for the new army units being wealthy and immature men. It is expected, therefore, that Congress will quickly grant the authority needed to call the reserve officers to camp with pay of their respective ranks, so that men with families may not be kept away.

For the first month's instruction the men in each camp will be organized into 15 companies of infantry. At the end of that time the men will be reorganized into one engineer and nine infantry companies, three batteries of artillery and two troops of cavalry. The coast artillery men will then be sent to Fort Monroe, Va., and Fort Scott, Calif.

Citizen applications for attendance are to be made at the nearest army department headquarters (Eastern Department, Governors Island, N. Y.; Central Department, Chicago; Southern Department, Fort Sam Houston, Tex.; Western Department, San Francisco).

Long Steel and Concrete Viaduct for Milwaukee River

A viaduct 1553 ft. long, composed of concrete arches and concrete-incased steel spans, is to be built at Milwaukee, Wis. It will carry North Ave. across the Milwaukee River Valley and will be constructed in connection with the separation of grades at that point. Beginning at Humboldt Ave., there will be a fill with retaining walls for 200 ft., followed by two or three small arches for 140 ft., and then 140 ft. of steel structure incased in concrete, crossing the Chicago, Milwaukee & St. Paul Ry. Next to this will be a series of arches for 330 ft., and then a 520-ft. section crossing the Milwaukee River by three concrete arches. The final section at the east end will be 223 ft. of fill with retaining walls, extending to Cambridge Avenue.

The viaduct will be level from Humboldt Ave. to the far side of the railway crossing and will then have a descending grade of about 3% to the east end. There will be a 40-ft. roadway and two 10-ft. sidewalks, while the present steel structure over the river has only a 17-ft. roadway and two 7-ft. sidewalks. The estimated cost of the new viaduct is about $390,000. Only general plans have been prepared as yet, but work on the detail designs has been commenced. This project is under the direction of J. C. Pinney, Jr., superintendent of bridges and public buildings.

Personal Notes

Albert Bell has been appointed engineer of the Fort Erie, Ontario, municipal water-works system.

Charles M. Babcock, of Elk River, Minn., has been appointed highway commissioner of Minnesota.

William W. Law, of Princeton, N. J., has been appointed technical adviser in the department of the State Architect.

A. R. Taylor, formerly surveyor of Hancock County, Ohio, has been named for the position of highway commissioner.

Carlton Miller has been appointed city engineer of Bracebridge, Ontario, to succeed Edwin J. Jukes, recently resigned.

Charles W. Cole has been appointed engineer for the construction of the Mishawaka Ave. bridge at Mishawaka, Indiana.

C. C. Hockley has accepted the position of chief engineer with the Thilmany Pulp and Paper Co., of Kaukauna, Wisconsin.

W. E. Baldry, city engineer of Dodge City, Kan., has been appointed city engineer of Topeka, Kan. He succeeds A. R. Young.

Robert E. Torrance, Kearny, N. J., has been appointed a member of the Passaic Valley District Sewerage Commission, New Jersey.

H. M. Garden has resigned as city engineer of San Angelo, Tex., his resignation to take effect as soon as another engineer can be appointed.

Herbert Nunn, Highway Engineer of Multnomah County, Oregon, has been appointed State Highway Engineer of Oregon, at a salary of $3600 a year.

Thomas J. Wasser, county engineer, Jersey City, N. J., has been appointed engineer for the County Boulevard Commission, succeeding Robert Gaw.

Alvah E. Foreman has been appointed chief engineer of the public-works department of the Provincial Government at Victoria, British Columbia.

A. E. Foreman, former assistant city engineer of Victoria, B. C., has been appointed chief engineer of the Department of Public Works for the Province of British Columbia.

C. L. Carman has resigned from the engineering force of the Chile Exploration Co. to become associated with Perin & Marshall, consulting engineers, 2 Rector St., New York City.

Walt Dennis, assistant engineer of the Chicago, Rock Island & Pacific Ry. at Chicago, has been appointed principal assistant engineer of the Wabash Ry., with headquarters at St. Louis, Mo.

Howard W. Green, former cost engineer for the H. Koppers Co. at Lorain, Ohio, has entered the Government service in the Canal Zone as water chemist at the Miraflores water-purification plant.

John L. Harrison has resigned as supervising engineer in the Bureau of Public Works, Manila, P. I., which position he has held for the past nine years. He is at present located at Fall City, Wash.

D. B. Steinman, recently special assistant to Gustav Lindenthal, consulting engineer, has joined the firm of Waddell & Son, consulting engineers, 165 Broadway, New York City, as associate engineer.

H. Ray Kingsley has returned to his post at Manila, P. I., as engineer in charge of building-engineering design for the Bureau of Public Works. He has been taking a few months' vacation in Chicago.

G. T. Kuntz, formerly division engineer of construction with the Gulf, Florida & Alabama Ry. at Pensacola, Fla., has been appointed assistant engineer of the Union Pacific R.R. at Omaha, Neb.

H. T. Critchlow, civil engineer, Ithaca, N. Y., has been appointed water engineer of the Department of Conservation and Development of the State of New Jersey, with headquarters in the State House, Trenton, N. J.

Christopher Harrison, since 1898 city engineer of Everett, Mass., was recently tendered a banquet by many of the leading citizens of that city on the occasion of his resignation to become city engineer of Montclair, N. J.

W. O. Hands, for 23 years in the Civil-Engineering Department of the Kansas City Rys. Co., has opened an office in the R. A. Long Building, Kansas City, Mo., where he will conduct a general engineering business.

Earl Loomis, formerly employed in the valuation department of the Southern Ry. at Washington, D. C., has recently resigned to enter the right-of-way department of the Central Railroad of New Jersey at Allentown, Penn.

Verne V. Long has become office engineer of the Benham Engineering Co., Oklahoma City, Okla. Mr. Long formerly was with Black & Veatch for three years, afterward becoming superintendent of water-works at Washington, Kansas.

R. R. Yates, of the firm of Harrington, Howard & Ash, consulting engineers, Kansas City, Mo., consulting engineers to the City of Dayton, Ohio, will succeed Paul D. Fuqua as engineer in charge of the bridge construction now under way in Dayton.

Searcy B. Slack has resigned his position as adjutant professor of civil engineering and field engineer of the University of Georgia, Athens, Ga., and has accepted a place as engineer with the Nixon-Smith Construction Co., Bell Building, Montgomery, Alabama.

T. J. Strickler, engineer, Public Utilities Commission, **Prof. H. A. Rice**, of Kansas State University, and **H. B. Walker**, of the Agricultural College, have been appointed members of the Kansas State Water Commission. Mr. Walker will be in active charge of the work.

O. L. Dillon, Jr., formerly with the Canal Construction Co., of Chicago (Ill.) and Memphis (Tenn.) as superintendent and engineer in charge of the Little River drainage contract at Kirk, Mo., is now connected with the Hoosier Land and Investment Co., of Sikeston, Missouri.

H. Peyton Mobberly, formerly chief engineer of both the Paris & Mount Pleasant R.R. and the Louisiana, East and West R.R., and division engineer of the Texas & Pacific Ry., has opened offices in the Woodruff Building, Springfield, Mo., and will practice general engineering.

W. G. Thompson, of Steelton, Penn., has been appointed assistant highway engineer of the New Jersey State Highway Department. Mr. Thompson was formerly engaged in roadwork in Connecticut and on the Panama Canal road and concrete construction work. His salary will be $4000 a year.

Paul D. Fuqua, who for the last two years has been assistant engineer in charge of the design and construction of the three new bridges for the City of Dayton, Ohio, has resigned to take the Chattanooga, Tenn., agency for the sale of Delco light products. He will have supervision over 25 counties.

Morris **Knowles**, consulting engineer of Pittsburgh (Penn.) and Boston (Mass.), has been engaged to make a study of the water-supply situation at Lawrence, Mass. **George F. Maglott**, assistant engineer, Massachusetts Institute of Technology, is local representative for Mr. Knowles at Lawrence.

M. F. Snell, recently employed by W. S. Barstow & Co. on power-house design and as field inspector, is now connected with the Chile Exploration Co., New York City. For several years Mr. Snell was shop detailer with Post & McCord and more recently was with Westinghouse Church Kerr & Company.

Frank J. Keis has resigned as city engineer of Watervliet, N. Y. Mr. Keis is a member of the firm of Solomon, Norcross & Keis, Atlanta, Ga., and during his service as city engineer has had under his personal supervision the construction of the Watervliet waterworks system, now practically completed.

Z. E. Sevison, of Laramie, Wyo., has been appointed State Highway Engineer of Wyoming. For the past four years Mr. Sevison has been located at Laramie as city and county engineer. He has also been engaged in general practice, which has included a large amount of road construction in that vicinity.

Theodore R. Kendall, who was in charge of the Agua Clara filtration plant at Gatun, C. Z., has resigned to become engineering editor of the *American City*. He was graduated from Harvard in 1912, and during the summer of 1914 studied foreign sewage-disposal and water-works installations in Europe.

Rudolph Hering, consulting engineer, announces that on Apr. 30 the firm of Hering & Gregory will be dissolved. Doctor Hering will continue to practice as consulting engineer in matters pertaining to water-supply and sewage and refuse disposal, with offices at the firm's present address, 170 Broadway, New York City.

Edward Flad, member of the firm of Edward Flad & Co., engineers, St. Louis, Mo., has been appointed a member of the Public Service Commission of the State of Missouri. Mr. Flad was formerly water commissioner of the City of St. Louis. He replaces H. B. Shaw, of Missouri University, as the engineer member of the commission.

Martin Schreiber, for several years engineer of maintenance-of-way for the Public Service Railway System in northern New Jersey, has been made chief engineer. This is a new office, the functions of which have been largely borne before by Mr. Schreiber. He has been with this company 14 years, and his largest work was the recently completed Newark terminal.

Albert L. Solleder, who has been in the employ of the United States War Department at Wheeling, W. Va., and the Dravo Contracting Co., of Pittsburgh, Penn., since graduating from Pennsylvania State University in 1913, has accepted a position with the New York Continental Jewell Filtration Co. in charge of the erection of a filtration plant for the City of Scranton, Pennsylvania.

Mason, Hilton & Co. and **Merrill-Ruckgaber Co.** have removed their offices to 120 Liberty St., New York City, and have associated themselves in the formation of the Cadmus Construction Co. They will continue their business as constructors of railroad structures, power developments, dams, etc., and as specialists in difficult foundations, pneumatic work, unusual structures and underpinning.

Watson Davis Miller Co. has been formed by Wilbur J. Watson, William R. Davis and Harlan Miller, who associated themselves to design a San Francisco-Oakland bridge. Offices have been opened in Cleveland (Ohio), Albany (N. Y.) and San Francisco (Calif.). Their work will consist of designing bridges, buildings, dams and docks, also irrigation and concrete work, and will include inspections, reports and estimates on engineering work.

Robert Fletcher, director, and **Charles A. Holden**, professor of civil engineering, of the Thayer School of Civil Engineering, Dartmouth College, have been directed by the attorney general of New Hampshire to make a survey of the west bank of the Connecticut River in the controverted case, now before the Supreme Court, to determine the division line between the States of New Hampshire and Vermont.

Olin B. Landreth, professor of civil engineering at Union College, Schenectady, N. Y., has been granted a leave of absence from college work for the year beginning September, 1917. Although, at his own request, he will be relieved of the administrative charge of work in the engineering department, Professor Landreth will remain a member of the faculty as professor of engineering practice, which duties he will resume at the expiration of his leave of absence.

W. R. Howard, recently assistant superintendent at Cincinnati of the American Tool Works, is now superintendent of the Ferro Concrete Construction Co., at Washington C. H., Ohio. While taking at the University of Cincinnati the co-operative course in civil engineering, which he completed in 1916, Mr. Howard was employed by the Big Four R.R. and, during the last three years of the course, by the Ferro Concrete Construction Co., with which concern he began his work as timekeeper.

George L. Luck, formerly connected with the Hastings Pavement Co., New York City, and **Lambert T. Ericson**, formerly engineer with American Creosoting Co., are contracting engineers with the Jennison-Wright Co., of Toledo. Mr. Ericson, who is a 1904 graduate of the civil-engineering department of the University of Illinois, has been engaged in the preservation of timber since 1907 with the Frisco Lines, as well as the Chicago & Eastern Illinois R.R., the Rock Island Lines, the Philadelphia & Reading Ry. and the Central R.R. of New Jersey.

J. P. J. Williams, for the past two years associate editor of the "Engineering Record" in charge of the structural steel and concrete field, has been appointed first assistant engineer of the Concrete Steel Engineering Co., of New York City. Since graduation from the University of Pennsylvania, Mr. Williams has had nine years' experience teaching structural engineering in various universities, including Pennsylvania, California and Columbia, and six years in designing and general engineering work with fabricating companies and railroads.

Fred. H. McKechnie has become associated with G. Ernest Booker in the firm of Booker & McKechnie, civil, mechanical and electrical engineers, with headquarters at Halifax, N. S. Mr. McKechnie, who graduated in civil engineering from the University of Toronto in 1909, has had several years' experience in railway construction with the Canadian Pacific Ry., the National Transcontinental Ry. and the Dominion Bridge Co. Prior to his work in Canada, he was in charge of the technical staff of the Uskside Engineering Co., Ltd., of Newport, England.

Charles S. Sincerbeaux and **G. Roland Moore** announce their formation of an engineering organization for furnishing engineering and surveying services, with offices at Asbury Park and Princeton, N. J. Mr. Sincerbeaux has had long engineering experience in private practice in the fields of sanitary, highway and drainage engineering and in the instruction of civil engineering at Princeton. He is engineer for the Mercer County Mosquito Extermination Commission. Mr. Moore has done considerable railroad surveying and engineering construction for the Pennsylvania R.R. Co. and general surveying for the City of Cincinnati, Mercer County (N. J.) and for private clients.

Allen B. McDaniel, assistant professor of civil engineering at Union College, Schenectady, N. Y., will assume administrative charge of the engineering department of that university after the close of the present college year, taking Prof. Olin B. Landreth's place. Mr. McDaniel graduated from the Massachusetts Institute of Technology in 1901. He was assistant engineer on the East River Division of the Pennsylvania tunnels, New York City, and has been, successively, instructor in civil engineering at the Case School of Applied Science, professor of civil engineering at the University of South Dakota and assistant professor of civil engineering at the University of Illinois. From 1909 to 1911 he was also president of the Missouri Valley Engineering Co. Professor McDaniel is the author of several books on earthwork and excavating machinery.

Obituary

Donald A. McLeod, contractor and builder, of Walla Walla, Wash., and at one time city street commissioner, died in that city on Apr. 4. He was a native of Nova Scotia and was 67 years old.

John A. Goll, head of the railroad contracting firm of John A. Goll & Co., Philadelphia, died on Apr. 19 at the Lancaster (Penn.) General Hospital. Mr. Goll's firm remodeled the Broad St. and Harrisburg stations of the Pennsylvania Railroad.

Herbert William Conn, Connecticut State Bacteriologist and professor of bacteriology at Wesleyan University, died on Apr. 18 at his home in Middletown, Conn. He was born in Fitchburg, Mass., in 1859. Professor Conn was lecturer at Trinity College, Hartford, for several years.

James Burke, superintendent of the Chicago Terminal division of the Erie R.R., at Chicago, died at his home in that city on Apr. 17. He entered the service of the Chicago, Milwaukee & St. Paul Ry. in 1873. After many years' experience in railway work on a number of Western railroads, he became connected, in 1902, with the Erie as engineer of maintenance-of-way at Cleveland. Later he was appointed superintendent of roadway, bridges and buildings, with offices in the same city, and in January, 1914, was appointed to the position of superintendent of the Chicago Terminal division. Mr. Burke was born at Oswego, N. Y., in 1856.

Earle C. Bacon, consulting engineer, M. Am. Soc. M. E., died at his country home in North Salem, N. Y., on Apr. 9. Mr. Bacon was born in Providence, R. I., in 1849, and was actively engaged in business for nearly 50 years. He started his career with the Delamater Iron Works, New York City, and, at the age of 21, formed a partnership with C. E. Copeland under the firm name of Copeland & Bacon. The firm was dissolved in 1893, and from that time until his death Mr. Bacon conducted the business under his own name, with offices in the Havemeyer Building, New York City. For nearly 40 years Mr. Bacon was associated with the Farrel Foundry and Machine Co., Ansonia, Conn. He was a pioneer in the development of hoisting engines and was also interested in mining engineering.

Engineering Schools

Massachusetts Institute of Technology

A new course in "Chemical Engineering Practice" has been started at Massachusetts Institute of Technology under the direction of Dr. W. H. Walker. The students are distributed at various "stations" in the East—centers of chemical industry. The men spend several weeks of close study of the practical details of work in various plants of the district. The men have no routine duties as workmen or apprentices, and some research investigation, testing, etc., is possible. The stations so far selected are Bangor, Maine; Stamford, Conn.; Niagara Falls, N. Y.; Northampton, Penn.; Everett, Mass.

Johns Hopkins University

An undergraduate course of lectures, on the methods and problems of engineering practice, has been founded at Johns Hopkins University, Department of Engineering, by J. E. Aldred.

The lectures will deal with the practical phases of engineering problems, rather than with underlying theory. They are not expected to discuss new and striking applications, as much as to deal with every-day working methods of design, construction and operation. Since the lectures are planned especially for undergraduate students, they will presuppose an elementary rather than an extensive knowledge of underlying theory. In 1917 three lectures will be given in each general subject of civil, mechanical and electrical engineering.

University of North Dakota

A reference bureau for municipal research has been established in connection with the extension work of the University of North Dakota. At present the bureau is at work upon the public-utility rates of the state. It is the purpose further to assist municipalities in the problems of public health, economic organization, water supply and elimination of wastes, through cooperation with the technical departments of the university. The State Geological Survey and the Public Health Laboratory are at work upon a comprehensive water survey of the entire state.

University of Pittsburgh

A hydraulic laboratory will be built by the University of Pittsburgh at Camp Hamilton, on Shade Creek, 4 miles from Windber, Penn. Funds for the building were provided by the trustees, and the site was given by A. R. Hamilton. The creek here has a fall of 20 ft. per mile, and about 100 cu.ft. per sec. is available. This location is the site of an old sawmill, where a 2000-ft. canal, 3 x 12 ft. in section and a walled wheel pit and tailrace still exist in good condition.

University of Michigan

The Graduate School of the University of Michigan now has seven industrial fellowships that are under the control of the Department of Chemical Engineering. These have been established by private interests, and the subjects studied are limited to matters of general interest. Publication of the results is unrestricted. Two fellowships are in gas engineering and were established by the Michigan Gas Association. One is in the manufacture of paints and varnishes and was established by the Acme White Lead and Color Works, of Detroit. One is in the pulp and paper industry and was established by a group of Michigan producers. One was established by the Detroit Edison Co., for the investigation of materials used in the construction of central-station equipment. One was established by the Detroit Copper and Brass Rolling Mills for the promotion of better copper products. One was established by the Detroit Steel Castings Co., for studies into the production of better steel castings.

Stevens Institute of Technology

With the completion of the Walker gymnasium, Stevens Institute has instituted definite courses in physical training. These require each student during all four years of his courses to spend two hours per week in individual and class work. Each student will be periodically examined and placed in one of three groups according to physical fitness for the work of those groups. Passing mark in physical-training courses will be required for graduation.

Engineering Societies

National Conference on City Planning—May 7-9. In Kansas City, Mo. Secy., Flavel Shurtleff, 19 Congress St., Boston, Mass.

American Water-Works Association—May 7-11. Annual meeting in Richmond, Va. Secy., J. M. Diven, 47 State St., Troy, N. Y.

National Fire Protection Association—May 8-10. Annual meeting in Washington, D. C. Secy., F. H. Wentworth, 87 Milk St., Boston, Mass.

American Society of Mechanical Engineers—May 22-25. Annual meeting in Cincinnati. Secy., C. W. Rice, 29 West 39th St., New York City.

American Institute of Chemical Engineers—June 20-22. Semiannual meeting in Buffalo, N. Y. Secy., J. C. Olsen, Cooper Union, New York City.

Engineers' Club of Philadelphia—May 15. Annual meeting at Engineers' Club, Edgemere, L. I. Secy., R. H. Fernald, 1317 Spruce St., Philadelphia, Penn.

American Society for Testing Materials—June 26-30. Annual meeting in Atlantic City, N. J. Secy., Edgar Marburg, University of Pennsylvania, Philadelphia.

American Iron and Steel Institute—May 25-26. General meeting in New York City, at Waldorf-Astoria Hotel. Secy., J. T. McCleary, 30 Church St., New York City.

American Institute of Electrical Engineers—June 25-30. Annual convention in Hot Springs, Va., at Homestead Hotel. Secy., F. L. Hutchinson, 29 West 39th St., New York City.